Sports Equipment

Selection, Care and Repair

Virginia Bourquardez, Ed.D.

The Sportswoman,
Bethesda, Md.

Charles Heilman, Ed.D.

Associate Professor, Health and Physical Education,
Drake University

A. S. BARNES AND COMPANY · *Established in 1838*

NEW YORK · 1950

PUBLISHED ON THE SAME DAY IN THE DOMINION OF CANADA
BY THE COPP CLARK CO., LIMITED, TORONTO

DEDICATION

To the physical education majors of the Texas State College for Women, especially the students in the Theory of Sports classes, who helped so materially in equipping me to write this book, I dedicate it with sincere appreciation and affection.

Virginia Bourquardez

To Marguerite, Steve and Bruce, whose enthusiasm and love make any task more meaningful.

Charles Heilman

Acknowledgements

The authors wish to express their gratitude and appreciation to Professors Harry A. Scott, Dorothy Houghton, John L. Hutchinson and Marjorie Hillas—of the Department of Health Education and Physical Education, Teachers College, Columbia University—for the help and encouragement given them throughout the writing of this book.

It would have been impossible to gather the material assembled in this volume without the help of the many individuals and organizations who supplied through correspondence or personal interview much of these data. To all these sources of reference, the authors acknowledge their indebtedness. Sincere appreciation and gratitude are here expressed to the following individuals:

Dr. John Dickson, United States Rubber Company, New York, New York, and consultant to the United States Army Quartermaster Corps; Mr. J. D. Zerbe, Jr., and Mr. J. Salmon, Promotion, Nylon Division, E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware; Mr. S. W. Brainard, Manager, Rayon Technical Service, E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware; Dr. H. E. Michael, The Cotton Textile Institute, New York, New York; Miss Mary North and Mr. Eugene Ackerman, The Wool Bureau, New York, New York; Mr. R. B. Akin, Plastics Department, E. I. du Pont de Nemours and Company, Inc., Arlington, New Jersey; Dr. George Linton, Mrs. Vi Vilag Cravet, Mr. Joseph Pizutto,

Mr. Arthur Rolfe, and Mr. Carmine Santopietro, members of the faculty of the Central High School of Needle Trades, New York, New York; Mrs. Myrtle K. Miller, Director, Teela-Wooket Archery Camp, Roxbury, Vermont; Mr. A. M. Schauffler and Mr. Van der Kogel, Abercrombie and Fitch Company, New York, New York; Mr. W. H. Jackson, The Robin Hood Archery Company, Montclair, New Jersey; Miss Helen Z. Stone, Helen Z. Stone, Inc., New York, New York; Mrs. Mary Brooks Picken, The Mary Brooks Picken Studio, New York, New York; Mr. R. F. Wheeler, Mr. George Temple, and Mr. J. N. Tynan, A. G. Spalding and Bros., Inc., Chicopee, Masachusetts; Mr. C. E. Carlson, former Director, Department of Research, Pennsylvania Rubber Company, Jeannette, Pennsylvania; Mr. E. Keuerleber, Ocean Pool Supply Company, New York, New York; Mr. H. E. Ralphs, M.C.C. Company, Ltd., Bedford, England; Mr. L. F. Sayers, John Wisden and Company, Ltd., Kent, England; Mr. H. H. Rice, Pennsylvania Rubber Company, Jeannette, Pennsylvania; Mr. Edwin W. Ely, Chief, Commodity Standards Division, National Bureau of Standards, United States Department of Commerce, Washington, D.C.; Mr. Leland Hunt, Chief, Rules Administration Division, Federal Trade Commission, Washington, D.C.; Mr. Hugo Castello, Castello Fencing Equipment Company, New York, New York; Mr. G. R. Auer, Bacharach-Rasin Company, Inc., Baltimore, Maryland; Mr. Patrick Warfield, W. J. Voit Rubber Corporation, Los Angeles, California; Dr. Bernath Phillips, Veterans Administration, Washington, D.C.

Of the many individuals who contribute to the success of any undertaking such as the writing of this book, there are always a few who with great fortitude, patiently lend ear to a continual barrage of questions and with equal calm and graciousness, supply the answers again, and again, and again. To three such stoic individuals the authors pay special tribute: Mrs. Marian Resnikoff and Mr. Aaron Rabinowitz, members of the faculty of the Central High School of Needle Trades, for their help with the textile and clothing sections of the book; and Mr. Vernon Smith, member of the sales personnel of Alex Taylor and Company, whose sound knowledge gained through many years of practical experience in handling equipment has been invaluable.

For their courtesy in submitting photographs to illustrate the text the authors are indebted to the following individuals and organizations: Mrs. Myrtle K. Miller, New York, New York; Mr. Fred Bear, Grayling, Michigan; A. G. Spalding and Bros., Inc., Chicopee, Massachusetts; Rawlings Manufacturing Company, St. Louis, Missouri; Wilson Sporting Goods Company, Inc., Chicago, Illinois;

Castello Fencing Equipment Company, Inc., New York, New York; Bacharach-Rasin Company, Inc., Baltimore, Maryland; Fashion Advertising Company, Inc., New York, New York; American Chain and Cable Company, Monessen, Pennsylvania; Whitestag Manufacturing Company, Portland, Oregon; Greta Plattry Sportswear, New York, New York; Jantzen Knitting Mills, Portland, Oregon; Doris A. Weston, Fashion Counselors, New York, New York; Garland Knitting Mills, Inc., Boston, Massachusetts; Algene Sportswear, New York, New York; Susquehanna Waist Company, New York, New York; E. R. Moore Company, Chicago, Illinois; W. J. Voit Rubber Corporation, Los Angeles, California; Ocean Pool Supply Company, New York, New York; Hillerich and Bradsby Company, Louisville, Kentucky; Drake University, Des Moines, Iowa; The Brunswick-Balke-Collender Company, Chicago, Illinois; Uline Arena, Washington, D.C.; U.S. Rubber Company, New York, New York.

The authors are particularly grateful to Marguerite Heilman and Lucy Bea From for their countless hours of assistance in typing the manuscript, and to Dorothea Sigel Tragle for her valuable help in editing.

Preface

Few manufactured items produced in large volume present as many or as diversified problems in design, tooling and fabrication as those encountered in the manufacture of sporting goods equipment.
Sporting goods as a whole, whether for group or individual use, are produced with the foregone acceptance that they will be subjected to constant and extreme abuse while in play, either from impact, torsional strain, abrasion, or in some cases a combination of all these at the same time. Despite this abuse, they must retain their original uniform qualities of size, shape, and life for long periods.
In addition, the problems of weight versus strength, and weight versus size are as vital in sporting goods equipment manufacture as in the aircraft industry, while uniformity of specifications, i.e., dimensional limitations, resiliency, rigidity, rebound, and aerodynamic flight, must be maintained within the closest of tolerances at all times.[1]

It is the purpose of this book to assist persons interested in purchasing athletic equipment to better understand these complexities associated with selection, care, and repair of sports equipment and to provide basic information necessary for an intelligent choice. Consumers cannot make truly satisfactory purchases unless they have

[1] James N. Tynan, "Manufacturing Laminated Tennis Rackets," *Mechanical Engineering,* 69:735, September, 1947.

this information. Choice, to be intelligent, must be related not only to the consumer's budget, but also to the functional properties of the equipment in relation to specific needs and the care necessary to obtain maximum value from the equipment. There is little time or opportunity for the average consumer to acquaint himself with

Table 1

ANNUAL EXPENDITURES FOR ATHLETIC EQUIPMENT[2]

Items	*Number Manufactured*	*Factory Value*	*Retail Value*[3]
Golf balls	28,884,000	$13,428,000	$22,100,000
Tennis balls	8,052,000	2,461,000	3,900,000
Baseballs	7,848,000	6,400,000	10,200,000
Softballs	4,860,000	3,819,000	6,100,000
Footballs	3,696,000	6,956,000	11,200,000
Bats	3,332,000	3,188,000	5,100,000
Ball gloves and mitts	2,184,000	8,236,000	13,177,000
Basketballs	1,080,000	5,114,000	8,200,000
Golf clubs (woods)	1,140,000	6,000,000	8,000,000
Golf clubs (irons)	2,700,000	10,000,000	17,000,000
Tennis rackets	——	1,995,000	3,100,000
Winter sports goods (skis, skates, etc.)	——	3,557,000	5,690,000

these facts. Sources of information are either limited and incomplete, or confusing because of multitudinous advertising claims and sales talk.

The need for wise expenditure of funds for sports equipment is evident when the proportion of consumer income expended annually for this purpose is considered. In 1948 approximately $600,000,000 was spent by consumers who needed or wanted sports equipment. This figure is exclusive of the $265,000,000 spent on women's sportswear alone. Table 1 presents a brief analysis of the production of and expenditure for sports equipment in 1948.

Since the end of World War II there has been a rapid increase in the number of participants in sports. This is due to several reasons: carry-over interest in sports of servicemen from military life to civilian life; realization by industrial corporations of the values in management-sponsored recreation programs; a shorter work-week;

[2] Stephen Feeley, "First Census of Manufacturers Report Since 1939," *The Sporting Goods Dealer,* 71:70, June, 1949. Only a partial list of activities has been included here.

[3] Approximate figures—not included in reference listed.

and the highest income average per capita in United States history.

At least five groups can use information regarding the selection, care and repair of sports equipment.

1. Individual consumers. It is nearly impossible for individual consumers to make satisfactory selection of equipment for themselves without first being able to identify some of the qualities such as durability, strength, performance and official regulations.

2. School and college purchasing agents and business managers delegated the task of purchasing athletic equipment. There are several guides and books of specifications available for these persons in their purchase of equipment such as school desks, chalk, ink and wall maps, but there is little or nothing available to guide their selection of equipment for their physical education program.

3. Physical educators and recreation personnel. This group is in daily contact with athletic equipment and, in most school, college and recreation programs is responsible for its selection and care: interest is high and the need for basic information is great.

4. Physical education and recreation students. Tomorow they will be the leaders in their respective fields. In the past, teacher education institutions have developed physical education teachers to work with people but in most schools, little or nothing has been offered to aid the new teacher in one of his most important tasks: to recommend or to select athletic equipment for his school or group. English, mathematics, social science and history students, to mention a few, are given undergraduate help in methods of selecting and evaluating such teaching equipment as audio-visual materials and textbooks, but in many cases not the physical education student.

5. Sporting goods dealers, both wholesale and retail. This book should assist dealers in the better understanding of consumer needs and of the type, quality and amount of equipment required to fulfill those needs. It may be used as a basic source for training sales personnel and as a reference for recent trends in methods of construction, styles, and new materials.

There are still many unsolved problems related to intelligent selection of sports equipment for which ready-made final solutions are unavailable. Minimum standards based on valid and reliable testing are greatly needed. Moreover, the knowledge of desirable functional properties is frequently limited by inability to recognize these properties in the finished product. Adequate labeling of equipment that would assist the consumer in this recognition is essential.

In the absence of other objective, scientific testing of equipment available to the public, specifications established by the United States Quartermaster Corps have been heavily drawn upon in the

gathering of data for this text. Certain obvious limitations due to wartime shortages of materials are therefore apparent in the specifications. Detailed listing of materials and methods of construction were, in many cases, likewise due to the exigency of this period. Future testing will no doubt place much greater emphasis upon the ultimate performance of the item tested.

As a single compact and comprehensive source of reference *SPORTS EQUIPMENT* should serve as a starting point from which the consumer can proceed to more intelligent selection of sports equipment. Its function is to guide or point the way. In this capacity it does not propose to supply the final answer. Constant revision will be needed to evaluate new types of construction and to encourage experimentation with new or improved materials. Basic materials such as plastics, laminated woods and light metals are changing almost daily; so are the methods of construction. As mentioned previously, there are still many unanswered questions due to the lack of minimum standards and labeling. On the other hand the fine equipment that may be obtained is indicative of the high standards that have prevailed. Close cooperation among sporting goods manufacturers, professional workers in the fields of health and physical education, and representatives of the various sports associations should eventuate in the attainment of even higher standards. It is the earnest hope and intent of the authors of this book that collaboration of this type be initiated as soon as possible.

October, 1950 The Authors

Table of Contents

CHAPTER	PAGES
Preface	xi
I. Archery	1
II. Baseball and Softball	28
III. Basketball	60
IV. Bowling	68
V. Boxing and Wrestling	76
VI. Fencing	89
VII. Field Hockey	101
VIII. Football	114
IX. Golf	141
X. Ice Hockey	167
XI. Lacrosse	177
XII. Racket Games (Tennis, Badminton, Squash)	187
XIII. Skiing	219
XIV. Soccer, Volley Ball, Handball	236
XV. Track and Field	248
XVI. General Care and Repair	261
XVII. Clothing as Equipment	272
XVIII. Materials (Leathers, Woods, Plastics, Rubber, Light Metals, Textiles)	299
Appendices	
A. Test Methods and Procedures	326
B. Functional Sportswear—A Check-list Questionnaire	334
C. Styling for Action and Fit—Suggestions for Purchasing	338
D. Good Garment Construction—Suggestions for Purchasing	341
Bibliography	345
Index	351

List of Tables

Number	Title	Pages
1.	Annual expenditures for athletic equipment	xii
2.	Height-weight measurements for target bows	16
3.	Arrow-bow proportional length measurements	18
4.	Size chart for baseball shirts	48
5.	Size chart for baseball pants	49
6.	Size chart for baseball caps	50
7.	Types of failures in sewn basketballs	61
8.	Size chart for boxing gloves	79
9.	Dimensions for fencing weapons	94
10.	Length-weight measurements for field hockey sticks	104
11.	Size chart for football jerseys	131
12.	Size chart for football pants	133
13.	Measurements for tennis rackets	199
14.	Measurements for badminton rackets	211
15.	Squash ball dimensions	218
16.	Care of textile fabrics	276–277
17.	Size chart for athletic supporters	294
18.	Comparative strength properties of woods	307
19.	The use of cotton in sports clothing and equipment	318
20.	The use of covered rubber thread in sports clothing and equipment	319
21.	The use of nylon in sports clothing and equipment	321
22.	The use of rayon in sports clothing	322
23.	The use of wool in sports clothing and equipment	324

List of Illustrations

		Pages
Figure 1.	Materials and tools for making target and field arrows, and bow strings	6
Figure 2.	Shooting equipment	7
Figure 3.	Target arrows	8
Figure 4.	A combination metal and wood bow (recurve type), with the standard parts of the bow indicated	10
Figure 5.	Materials used in construction of bows	11
Figure 6.	A metal recurve bow at full draw	12
Figure 7.	The conventional bow at full draw	12
Figure 8.	Wooden reflex bows at full draw	12
Figure 9.	Bow grips showing arrow rest and arrow plate at top of bow grip	15
Figure 10.	Set of field target faces for a field archery round	17
Figure 11.	Bow string (double loop) showing serving and nocking point	19
Figure 12.	Finger tabs and shooting glove	22
Figure 13.	Processes in the construction of a baseball	30
Figure 14.	A set of official baseball bases	32
Figure 15.	A top quality, grade one autographed bat	36
Figure 16.	Baseball body protectors	38
Figure 17.	Baseball mitts	41
Figure 18.	A shin guard with the four-rolled corrugation	42

Figure 19. Catchers' masks 43
Figure 20. Several styles of major league baseball shirts 47
Figure 21. Shoes and masks 52
Figure 22. Softball uniform 57
Figure 23. Basketball uniform 66
Figure 24. Bowling ball 70
Figure 25. Duck pin balls 71
Figure 26. Bowling pin 73
Figure 27. Candle and duck pins 74
Figure 28. Boxing gloves (match) 78
Figure 29. Two types of striking bags 80
Figure 30. Boxing gloves (striking bag) 82
Figure 31. Protective headgear for boxers 83
Figure 32. Fencing weapons 91
Figure 33. Standard parts of a fencing weapon 92
Figure 34. Masks 95
Figure 35. Fencing costume 97
Figure 36. Field hockey stick 102
Figure 37. Field hockey balls 105
Figure 38. Field hockey shin guard 107
Figure 39. Goalkeeper's leg guard 108
Figure 40. Field hockey shoes for women 111
Figure 41. Football helmets 117
Figure 42. Football helmet with extra protection to the jaw 119
Figure 43. Shoulder and hip pads for football 120
Figure 44. Football uniform 129
Figure 45. Football pants 131
Figure 46. Composition of a golf ball 145
Figure 47. Three stages in the development of a golf wood 149
Figure 48. Stages in the development of golf iron club heads and the finished product 151
Figure 49. A complete set of golf clubs 154
Figure 50. Head covers for the four woods 155
Figure 51. Clothing worn for golf 158
Figure 52. Golf shoes 162
Figure 53. Ice hockey sticks and puck 168
Figure 54. Goaltender's equipment 173
Figure 55. Lacrosse uniform and component parts of a lacrosse stick 179

Figure 56. Tennis ball construction 191
Figure 57. Steel tennis net 193
Figure 58. Component parts of a tennis racket 195
Figure 59. Tennis rackets 196
Figure 60. Badminton rackets 210
Figure 61. Stitchless outdoor shuttlecock with thermoplastic base 213
Figure 62. Squash rackets 216
Figure 63. Laminated skis with bindings and steel edges and metal climbing poles with welded steel tip 221
Figure 64. Clothes for skiing 229
Figure 65. Ski boots 231
Figure 66. Soccer ball—rubber covered 238
Figure 67. Volley ball—rubber covered 243
Figure 68. Track shoes 257
Figure 69. Sport sweaters 279
Figure 70. Sport shirts, pedal pushers, slacks 282
Figure 71. Gymnasium costume, one-piece suits 289
Figure 72. Gymnasium costume, two-piece suit and tank suit 291
Figure 73. Apparatus for determining straightness of bats 327
Figure 74. A rebounding machine for all spherical balls 330
Figure 75. An impact tester for footballs 330
Figure 76. A machine for testing the covers of golf balls 333
Figure 77. A device for testing a baseball or softball for resistance to an impact 333

Sports Equipment

CHAPTER I

Archery

Using the bow and arrow is perhaps one of the oldest activities of civilized man, but it was only in comparatively recent times that it became an activity for recreation rather than a means of self-preservation. Egypt was the first nation to adopt the bow and arrow as a means of warfare and with it gained domination over neighboring countries. Other nations soon discarded their javelins and spears in favor of this new weapon and the bow and arrow was elevated to and maintained its place as the world's foremost military weapon for the next 2500 years.

The invasion of the Spanish Armada in 1588 and the resulting battle between the Spanish armies, equipped with bows and arrows, and the English defenders, equipped with firearms, started the decline of bows and arrows as a method of warfare.

Toward the end of the sixteenth century, archery began to gain widespread recognition as a sport. King Charles II of England sponsored archery for his people and soon other European nations approved it. The first national championship meetings were held in 1844.

Archery as an organized sport had its beginning in the United States in 1828 when an organization known as the United Bowmen of Philadelphia was founded. The history of archery in the United States follows very closely that of England. The Civil War in America retarded the growth of archery for almost twenty years, just

as the Napoleonic Wars had affected the early archery societies in England. The sport was assured some form of permanency in 1879 when the National Archery Association was founded. The first tournament was staged the same year and has been held annually except during World Wars I and II.

As an outgrowth of one of man's earliest activities, hunting, archery in any of its various forms is essentially an outdoor sport. This does not preclude the use of target archery indoors when facilities and weather require, but does limit hunting and flight shooting to outdoor areas. Equipment, therefore, must be durable and fairly constant in performance under varying weather conditions of heat and moisture. Arrows must be sufficiently durable to withstand contact with the ground or target stand without breaking, and must be waterproofed since either ground or target may be wet.

The fashioning of bows and arrows has always been more of a craft than a streamlined method of manufacture. Each individual bowyer and fletcher brings to his task the loving, personal attention that is characteristic of the true artist. Manufacturers, although working on a larger, more mechanized scale, have the same keen understanding of tackle properties and function. Any discussion of tackle is, therefore, bound to be controversial. Unless documented by reliable and valid testing, statements can reflect only the best available opinion based on performance. Such sources have been utilized for the information contained in the following discussion of archery tackle.

Equipment Tackle

- Arrow
- Bow and bowstring
- Target
  - backstop (indoor)
  - stand and face
  - anchor (stakes)
- Armguard
- Shooting glove and tab
- Quiver (ground, belt)
- Bow case
- Bow sight
- Floor quiver (indoor)
- Target covering
- Arrow tassel
- Points of aim
- Bow rack
- Costume
  - dress
  - shirt
  - skirt
  - sweater
  - pants
  - hose
  - shoes

Arrow

The well-worn simile "as straight as an arrow," although technically incorrect, does indicate the primary requisite for any good arrow—that is, accuracy in flight. When released from the bowstring

the arrow at first travels outside the direct path to the target, since it must bend around the bow shaft, but, if properly spined (the term spine refers to the give of the arrow shaft, or its ability to bend—the coefficient of stiffness in relation to the weight of the bow) and accurately shot, it returns to the true course. Qualities essential to a good arrow are, therefore, (1) straightness for accuracy in flight; (2) proper spine; (3) lightness for speed in flight; and (4) good quality fletching.

There are four principal parts of an arrow, namely, the shaft, pile, nock and fletching. For decoration and identification purposes, a crest is painted on the shaft near the feathers.

TYPES. Arrows are made from wood, metal or plastic. The latter two materials are products of the technological, industrialized age, and, to the old-time archer, bear little relation to the tackle he knows best and still uses—wood. However, in spite of sentiment and tradition, the functional properties of the man-made products seem destined to prevail.

Self arrows (made from one piece of wood) are approximately half as expensive as footed arrows of comparable quality. Footed arrows have an additional wood (footing) inserted into the foreshaft of the arrow. It is a hardwood, usually beefwood, and gives added strength to the portion of the arrow that most needs it, the part that contacts the target. Most archers prefer arrows of this type. However, those who prefer self arrows claim that footing spoils the arrow balance by making the foreshaft heavier and requires the arrow to have more spine in order to be set off in flight. Other critics maintain that footing allows moisture to enter at the spliced sections and thereby decreases the straightness of the shaft.

The plain, unfinished wood, cylindrical in shape, from which the finished arrows are fashioned, is called a dowel. Wood in any good arrow must be straight-grained. Equally important is stiffness (or spine). Arrows that lack this quality have a low vibration and will not fly straight to the target. Every good arrow must be able to bend around the bow handle and pursue a straight course to the target. Straightness of arrow shaft also contributes to accuracy in flight. To determine this property, glacé down the arrow shaft from nock to pile.

Wood. Arrows are made from various kinds of wood. Port Orford cedar is considered the most satisfactory of all woods for arrows. It has excellent spine, and, with careful handling, remains straight throughout continual usage under normal conditions. Arrows made of this wood are more expensive than those constructed of birch.

Birch is a tough and durable wood, but tends to warp more than cedar. Birch arrows are fine for beginners. Douglas fir, a tough wood, is excellent for hunting and flight shooting. Forgewood shafts are made from compressed cedar and are extremely tough and durable. Arrows of this type are comparatively new, and, therefore, are less well known and less used than birch or Port Orford cedar.

For beginners, inexpensive birch self arrows are very practical. The basic elements of shooting can be learned satisfactorily with these arrows, and a better quality arrow can be adopted when skill increases.

Plastic. Tubular plastic glass arrows have properties similar to metal. They are uniform in balance, diameter and other properties, and do not break. However, being less compact than metal, they offer more wind resistance and may, therefore, be less accurate than metal in flight. These arrows are too new to be commonly used to date.

Metal. Arrows made of tempered aluminum alloy have supplanted wood arrows for tournament use. They are clearly superior to wood. All metal arrows are lightweight, straight, have excellent spine, and are uniform in every respect. Since they are unaffected by moisture, they will not warp in wet weather. Beginners should not use metal arrows since contact with stones and other hard objects may cause the arrows to break. Two drawbacks to their use by more skillful archers follow: they are costly, approximately one-third more expensive than the best wood arrows, and, when bent, they are more difficult to straighten. When cost is compared on a long term basis, the metal arrow is not as expensive as the selling price indicates. Individuals and institutions that can afford the initial cost outlay should carefully consider the purchase of metal arrows.

Properties. Arrows of better quality are matched in weight, spine and balance so that they will shoot smoothly and consistently. Accurate methods of testing arrows for each of these properties are used by many manufacturers. Some combine tests for weight, spine and balance with flight by means of a machine that shoots the arrows. Manufacturers classify or place arrows into specific price groups according to the area into which they fall, and the closeness of the clusters or grouping. Matched arrows, guaranteed to conform to these specifications, can be secured in both the self and footed varieties. The better the quality of arrow, the closer the matching in both weight and spine.

Weight is estimated in grains. Target arrows range in weight from 250 to 300 grains. Top quality arrows vary only 3 to 5 grains in weight. The average arrow varies 5 to 10 grains. Field arrows are heavier than target arrows. Spine, determined by the amount of bend or flexure for a given load, is contingent upon the bow used. The best arrows are matched to within ½ to one ounce in spine. An extra charge is made for a rough check of spining of arrows that are not matched.

Arrow diameters range from ¼ to 11/32 inch. The smaller the circumference, the less the wind resistance of the arrow and the proportionately weaker the spine. In order to maintain both strength and wind resistance, some arrows are barrelled, that is, they are wider in circumference in the center of the shaft where more strength is needed and taper to a smaller diameter at each end. Tapered arrows, as distinguished from the barrelled variety, have a larger diameter at the point and taper gradually to the nock. Less expensive arrows are uniform in diameter throughout the shaft.

Correct arrow length is very important to both the skill and safety of the archer. Too short an arrow causes a cramped shooting position and may result in overdrawing and breaking the arrow. An arrow that is too long makes accurate aiming impossible, and may cause injury to the arm at the elbow joint when the string is released.

One method of determining correct arrow length is to base it on the proportional relationship between an individual's arm length and height. This average measurement is inaccurate because an individual's arm length and height do not necessarily conform to such a standard measurement, and because the length of the draw may vary for two individuals of the same arm length and height.

Another method of ascertaining arrow length is to measure the arm spread, then find correct arrow length and bow length on a chart that has been calculated by archery experts.

However, for a truly *accurate* measurement a trial draw is essential, since it is based on the actual drawing length of each individual archer. Mark off in inches on a 28 inch arrow the range in arrow length, and then have the archer assume full, correct draw position with a very light bow (not over 18 pounds and at least 5½ feet long). Trained instructors can quickly determine correct arrow length of large groups by this method.

To assist archers in maintaining a draw that is consistent in length, attach a draw check to the bow. This is a rubber indicator over which the arrow passes in the draw. When the arrow is back to full draw, the tiny rubber flipper comes up in front of the arrow point. Be sure that the arrow is long enough to avoid overdrawing.

Archers and manufacturers disagree as to the correct way of measuring the actual length of an arrow. At the present time, the most agreement seems to be on the measurement of length from the end of the nock to the front of the pile (not including the tip).

Steel or brass points (piles) are attached to the foreshaft end of the arrow. Brass points are better because they will not rust. For target

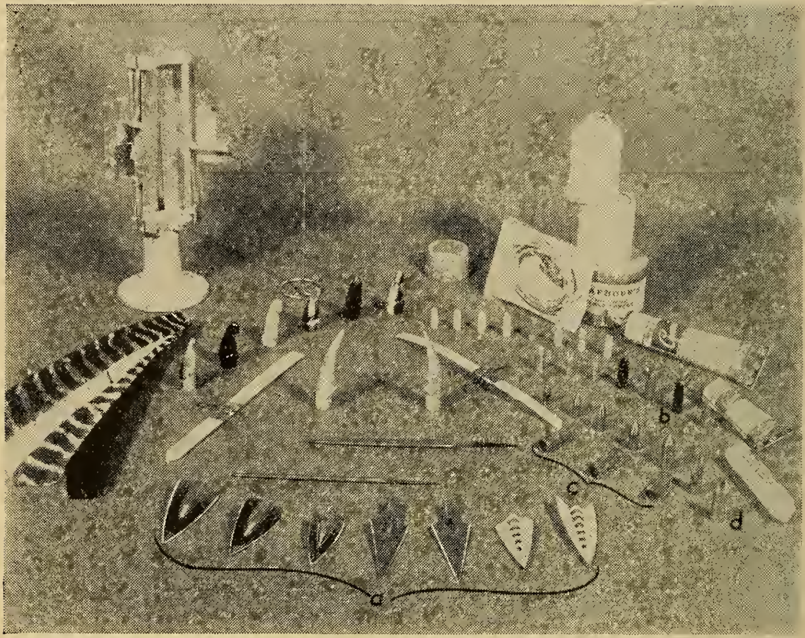

Figure 1. Materials and tools for making target and field arrows, and bow strings: (a) broad heads, (b) parallel point, (c) blunts, (d) bullet point. (*Photograph by The Ballard Studio, Detroit. Courtesy of Fred Bear.*)

archery, points are either parallel or bullet shaped (see Figure 1). The parallel points are the more extensively used and are more durable. A nonskid arrow pile is used in archery golf and field archery to make the arrow remain where it hits (see Figure 2). For hunting and in one round of field archery, broadhead points are used on the arrows. These points are heavier and much sharper than the target archery points. Blunt heads are also used in hunting (see Figure 1). In order to fit securely and remain in place, points may be knurled, a process whereby an indentation is made in the point and the metal is then pressed into the wood. However, this

method weakens the wood and may cause fracture. A ferrule cement, similar to that used on fishing rods, is excellent for attaching the points to the shafts.

The end of the arrow into which the bowstring fits is called the nock. In the past nocks have been made of horn or fiber. Today molded plastic (pyroxylin) nocks are preferred, since they can be burned off easily when replacement is indicated (see Figure 3).

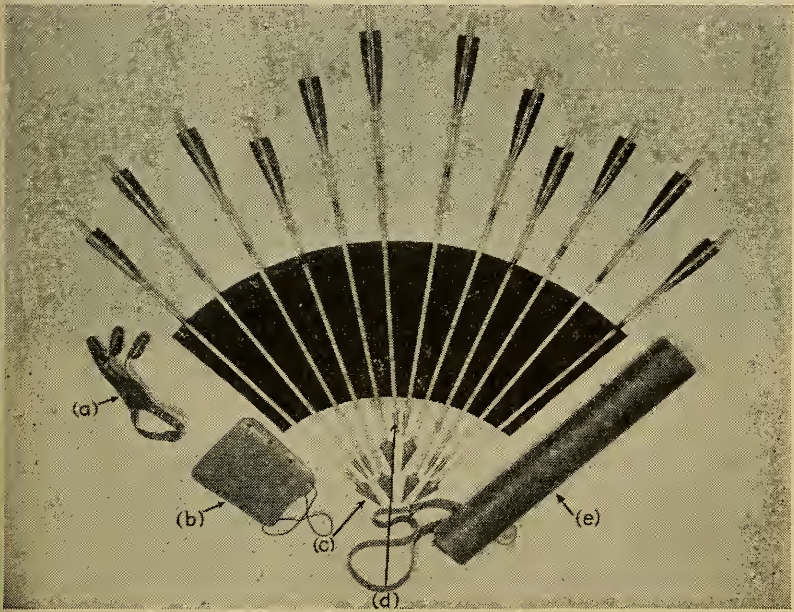

Figure 2. Shooting equipment: (a) glove, (b) arm guard, (c) hunting arrow (broad heads), (d) field arrow (non-skid points), (e) quiver. (*Courtesy of Fred Bear.*)

Three feathers are placed on the shaft of each arrow ahead of the nock. The application of feathers to arrow shaft is termed fletching, and the old-time fletcher who could perform this operation by hand accurately and quickly is fast disappearing. Today, with very few exceptions, fletching is accomplished by means of fletching jigs, which set the feathers on at 120 degree intervals. Feathers should be evenly spaced and may be placed either in a straight line with the shaft or in a spiral position. Spiral fletching spins the arrow similar to the spinning action of a bullet as it travels through the air. For this reason, many archers prefer this type of fletching. Field arrows require quicker stabilization than those used in target archery, and,

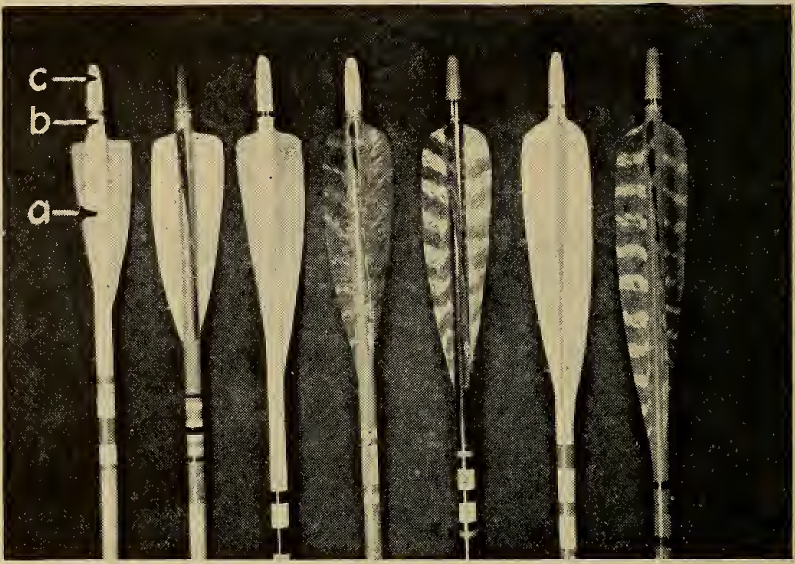

Figure 3. Target arrows: (a) fletching, (b) crest, (c) nock.
(*Courtesy of Fred Bear.*)

therefore, have a longer fletching. In the better quality arrows the feathers are matched for texture, thickness and color. Large wing feathers from a turkey are the best to use, and the feathers should all be from the same side of the bird (right or left wing). It has been estimated that it takes five turkeys for a set of one dozen arrows. The feather perpendicular to the nock (cock feather) may differ in color from the other two feathers (hen feathers).

Arrows of each archer are identified by the crest that is painted on the shaft below the feathers. Each archer uses a crest of distinguishing color and pattern in a tournament, and sets of arrows are manufactured with different style crests (see Figure 3).

In official tournaments the rule states that:

> Any type of arrows except those that would unreasonably injure the target or target face may be used. (Note—the arrows of each archer must have a distinctive mark, usually identified by the colored crest.)[1]

Arrows with cracks or breaks in the shaft are a great menace to safety. Inspect all arrows carefully, and break in two any that are

[1] "Official Rules for Target Tournaments," *Official Individual Sports Guide*, 1950–52, p. 34.

questionable. Caution beginners to watch for any arrow that may have this splintering at the pile end; if such an arrow is shot before being repaired, the splintering will follow up the shaft when it enters the target and the arrow will be ruined. Also, there is danger of getting slivers in the hand on the release.

Check new arrows for any glue deposits, especially on the feather to the left of the cock feather, and rub off excessive glue with sandpaper. This part of the arrow rides across the top of the hand, and if it is not smooth will scratch the hand. The top of the hand can be protected with a band aid or adhesive before there is further irritation. If the nocking point is too low the arrow will often scratch the hand. The arrow should be nocked exactly opposite the arrow plate or a bit higher.

Stress the danger of overdrawing an arrow as the arrow may break and go through the hand. Arrows of 26 or 27 inches are advisable for *beginners* at first to avoid any possibility of overdrawing. If an arrow slips off the left hand during the draw, take the draw again. Trying to recover the arrow while at full draw may cause the arrow to buckle up and break and go through the hand.

Bow

Several types of bows constructed from various kinds of wood are available. Regardless of the specific advantages of any one bow, all good bows must have the following qualities: (1) strength and resiliency in order to bend without breaking, and sufficient cast (the property in the wood which gives the bow the power to send the arrow forward) to send the arrow over the specified distance without too high a trajectory, and to maintain shape throughout constant use; (2) high resistance to temperature and atmospheric changes, including heat and moisture, so that the sight will not have to be continually adjusted as these conditions change; (3) a comfortable and smooth draw in order to release without jarring; (4) perfect balance between each limb to insure smoother cast and consequently longer bow life and to distribute stress evenly. The upper limb is longer than the lower limb. Bows must be held with the longer limb up when shooting.

A bow is composed of the following parts: upper and lower limb; handle; front (belly); back; and upper and lower nock (see Figure 4). The bowstring which forms part of the bow has either two loops, one on each end of the string, or a single loop, with a timber-hitch knot tied at the lower nock. The serving is the reinforced part of the string opposite the handle of the bow. The place on the serving on which the arrow fits is called the nocking point. The arrow plate

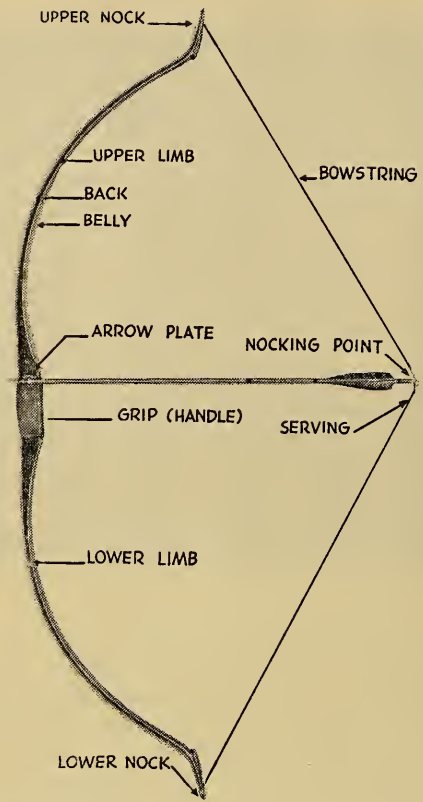

Figure 4. A combination metal and wood bow (recurve type), with the standard parts of the bow indicated. (*Courtesy of Fred Bear.*)

which may or may not be indicated on the bow is immediately above the handle of the bow. This is the point at which the arrow should pass. Descriptions of bows may mention that the bow was made from a billet or stave. These terms refer to two different kinds of logs (see Figure 5).

A slab of wood three feet in length and cut from the outside of a log is termed a billet. This wood is then split down the middle to form the two limbs of a bow. A forked splice joins these limbs, and is concealed under the bow handle. Both limbs are identical in quality and other properties since they are part of the same tree growth. A stave is a continuous full bow length ready to be made up.

Tillering refers to the process whereby the bow is shaped to correct curvature. Bows of semi-flat styling are used more generally than the flat variety. In the former style, the mid-section of the bow is thicker. The back is flat but there is greater thickness in the belly.

The kind and placement of materials in a bow vary in construction. A self bow is made of one kind of material without a backing.

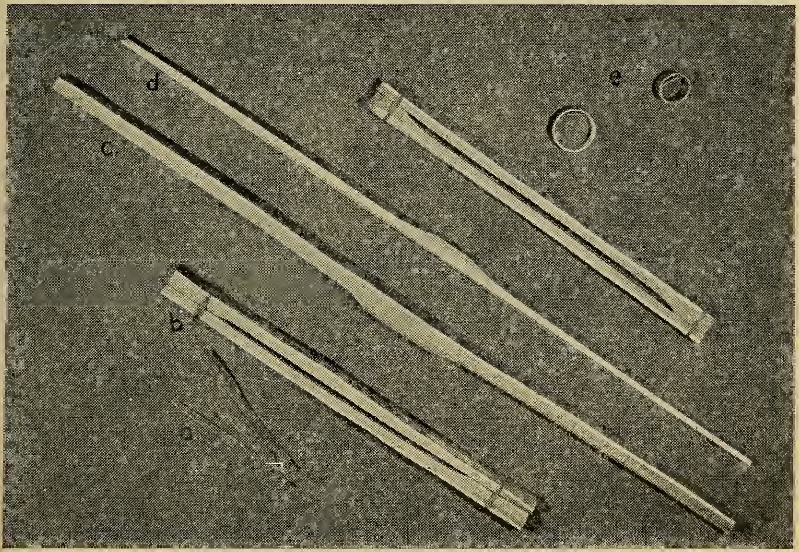

Figure 5. Materials used in construction of bows: (a) leather grip covering, (b) new billets, (c) roughed-out yew stave, (d) yew stave ready for final tillering and finishing, (e) rolls of fortisan backing for bows. (*Photograph by The Ballard Studio, Detroit. Courtesy of Fred Bear.*)

A backed bow is one in which backing is applied in order to protect the bow from rising splinters, and, if applied with tension, to reflex the bow limbs. Backing may be made of fiber, rawhide, fortisan and other materials. Fortisan is a synthetic fiber more than twice as strong as silk and very elastic. It has replaced the silk backing. A faced bow is one which is generally faced with a material of higher compressive qualities than other materials in the bow. For this purpose, osage, toxhorn, buffalo horn and baleen are commonly used. Facing contributes to improved cast and permanent reflex. A composite bow is made from a combination of a number of materials. Oriental bows composed of horn, wood, sinew and leather are examples of com-

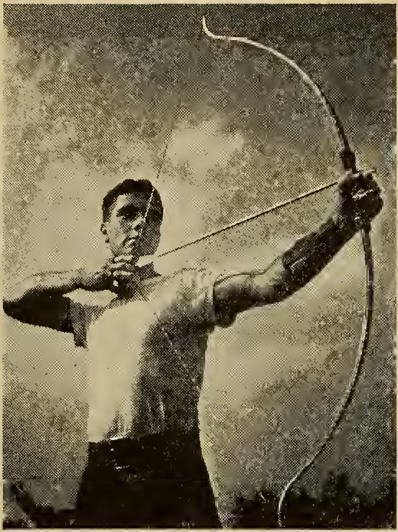

Figure 6. A metal recurve bow at full draw. (*Courtesy of Myrtle K. Miller.*)

Figure 7. The conventional bow at full draw. (*Photographed by Jerome Moga, Niagara Falls. Courtesy of Myrtle K. Miller.*)

Figure 8. Wooden reflex bows at full draw. (*Courtesy of Myrtle K. Miller.*)

posite bows. A laminated bow is made from a combination of three or more layers of materials joined together. These bows may be made from the same or different types of materials and are more durable but also more expensive than self bows.

Variations in design directly affect the cast of the bow (and its cost). The following styles in bows are listed in the order of increasing amount of cast and cost as follows:

1. Straight bow. A bow in which there is little or no reflexion. This is the conventional bow of flat or long bow design (see Figure 6).

2. Reflexed bow. Reflex limbs are set back so that they extend in the direction of the flight of the arrow when the bow is unbraced (see Figure 7).

3. Recurved bow. In a straight bow the tips are recurved by means of steaming. The bow then retains this shape. Recurved ends are two to six inches long and speed up the velocity by reflexive action (see Figures 4 and 8).

4. Duoflex bow. Each limb of the bow is S shaped so that the two curves are in opposition to each other, with the section of the limb near the handle curved in the direction of line of flight of the arrow, and the other half of the limb curved in the opposite direction. As a result, the bow when braced is not under pressure, reflex starts when the bow is drawn, and the draw and release are smooth, comparatively effortless, and without any kick. The bow resembles the traditional concept of a cupid bow.

TYPES. Bows are constructed from wood, metal or a combination of these two materials.

Wood. When selecting bows observe the wood for straightness of grain. This is easy to check in osage and yew, but difficult in lemonwood (see Woods, pages 304–310). Clear, straight-grained wood is morse costly than discolored, scarred or knotty wood. Lemonwood, Osage orange, yew and hickory are used in bows.

Lemonwood is considered the most consistent, all-round wood for bows, whether for class use, individual recreative purposes, or tournament competition. Imported from tropical regions throughout the world, especially Cuba, this wood is lemon in color. It is moderately priced when compared to other bow woods of comparable quality and is less affected by atmospheric or temperature changes. However, when constructing a bow of lemonwood it is difficult to follow the grain of the wood, and, therefore, few of these bows are straight-grained. Lemonwood is at its best when it is brittle, and because of this condition is very subject to breakage.

Osage orange is a tough, durable wood, and has a fast cast, but lacks the smoothness of lemonwood and yew. Because of its fast cast it is especially good for hunting. It is orange-brown in color and grows in abundance in some areas of the southwest and midwest United States. Although similar to lemonwood in performance, osage orange is more expensive due to scarcity of supply and difficulty in manufacture.

Yew, considered by many to be superior to all other bow woods, is dark in color and is known for its excellent cast and even grain. It is extremely sensitive to changes in temperature and humidity. Tournament archers have had to adjust their sights and points of aim frequently as the sun rose or humidity increased. Backing on the bow helps to counteract this tendency. The high cost of yew makes yew bows prohibitive for most archers. High cost is governed largely by the need for hand operation in manufacturing a bow in order to follow the winding grain of the wood, the expense in cutting it due to the scarcity of this type of wood, and the inaccessible areas where yew of good quality grows. Yew and osage are the two woods used in flight shooting bows.

Hickory is only slightly cheaper than lemonwood, but is considerably inferior in quality. It is a tough wood and durable, but has little or no cast because of its great elasticity. It may serve well as backing on a bow.

Metal. Bows made of aluminum or tubular steel have excellent cast and are not affected by temperature, but are very expensive. Aluminum bows can break and there is considerable danger involved when this occurs. Tubular steel bows have never been known to break in use.

Combination Wood and Metal. One of the most recent developments in the manufacture of bows is one composed of five very thin layers of fiber glass for the backing material, a layer of maple for the core, and a layer of aluminum on the belly side. A fine strip of wood covers the aluminum to form the belly of the bow. This layer is added mainly for decorative purposes and to cover the aluminum alloy. This bow is unaffected by temperature, has tremendous velocity and is excellent for hunting, as well as for other forms of archery (see Figure 4).

PROPERTIES. The handle of women's bows should be at least one inch thick, those for men, 1 1/8 inches. The handle, approximately 4 inches long, tapers sharply so that the center of each limb is about 5/8 inch thick. A handle riser is a piece of wood that is glued onto the bow to form the handle.

Inexpensive bows have self nocks fashioned from the wood of the

limbs. On the more expensive and better quality bows the nocks are joined to the limb. Plastic tips are used for this purpose. Nocks should be smoothly grooved for good fit and long life of the bowstring. Hunting and field bows may have brush nocks which are designed to prevent the brush from lodging between the bow and the bowstring.

Leather is wound around the handle to form the grip. Cordovan

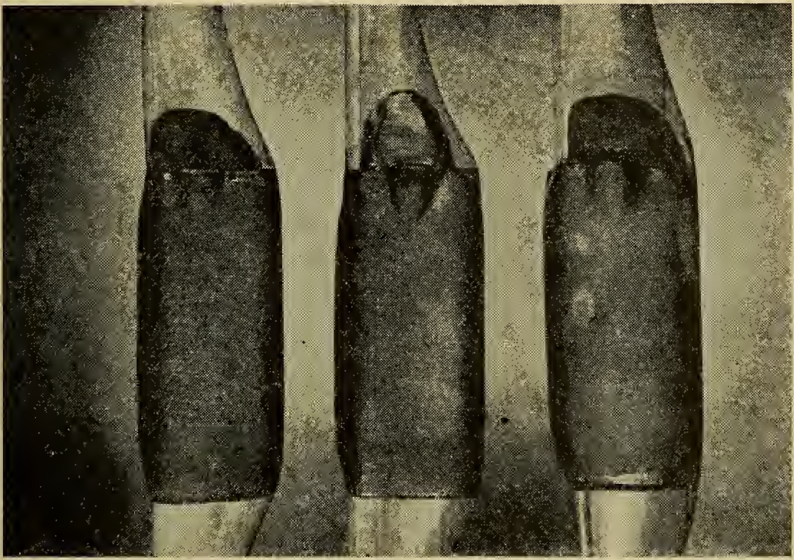

Figure 9. Bow grips showing arrow rest and arrow plate at top of bow grip. (*Courtesy of Fred Bear.*)

leather, the smoothest, most expensive covering, is excellent for good wear and smooth release. Cork grips and those made of cord are adequate and cheaper, but not as serviceable as leather, as they have a tendency to adhere to the hand (see Figure 9).

A neat, smooth, polished appearance is important to bows, and a good varnish for protection against moisture, dirt and other harmful agents is essential. Other finishing details, such as hand-fashioned leather grips and decorative tips, contribute to eye appeal and add to the cost, but do not affect performance. Bows that have not been completely finished can be purchased and finished by the purchaser at a considerable saving. Inlaid arrow plates are preferable to those that are stamped on because they are flush with the bow, and, therefore, enable the arrow to remain closer to the bow, which affects its accuracy in flight.

In most sports the size and weight of the equipment depends

mainly on the size and build of the individual. Archery imposes an additional factor that must be taken into account—the muscular power of the individual necessary to draw the number of pounds of pull used to bring the bow to a full draw. Weight of the bow, therefore, is a measurement of drawing weight. According to Myrtle K. Miller, former International Women's Archery Champion,

> The bow must have a drawing weight suited to the individual using it. It must be neither too heavy nor too light for his muscular power and it should not be too short nor too long for his height or his drawing or arrow length. A very long bow used by an individual with a short draw (drawing a short arrow) will not have sufficient cast to send the arrow to the target in a way that will give pleasure to the one shooting it. In order to have the arrow reach the target with such a bow it must be given a very high trajectory, necessitating aiming it so far above the target that definite aiming and accurate shooting are impossible. A very short bow used by a person drawing a long arrow is apt to break because of being overdrawn. . . .
>
> A bow too heavy will make it impossible to assume correct position and will encourage a forward left shoulder and other peculiarities of position detrimental to good shooting form and good posture.

Adults, both men and women, generally use a 5 foot 6 inch bow. Individuals who are shorter than average may find a 5 foot bow more suitable, and very tall men may prefer a 6 foot bow, although these are fast becoming passé. A 4 foot 6 inch bow is average for children of a shooting age, although some "cubs" as young as four years of age have been known to shoot even a 3 foot bow. In terms of skill, the average bow weight for men and women varies about 2 to 4 pounds, for beginners and intermediates. Men who are in the advanced class can shoot up to a 45 pound bow, which is 15 pounds heavier than the weight used by women. Table 2 shows the approximate measurements of target bows in weight and height generally used by archers in the various skill levels.

Table 2

Height-Weight Measurements for Target Bows

	Height	*Weight in pounds*		
		Beginner	*Intermediate*	*Advanced*
Women	5′6″	14–16	18–22	22–30
Men	5′6″	18–20	22–28	28–40
Boys	4′6″	12–18	18–22	Up to 32
Girls	4′6″	10–12	14–18	Up to 26

For hunting and field shooting a bow that is 10 to 20 pounds heavier than a target bow is used. In these types of shooting the archer cannot hold the aim as long as in target archery, and, therefore, a heavier bow can be managed. The size of the bow will vary according to the size and type of animal that is being hunted. Bow weights range from 40 to 80 pounds approximately. For easy handling and more forceful impact these bows are shorter and wider than target bows. Flight shooting yew bows are 5 feet or a few inches shorter. The handle is in the exact middle of the bow so that

Figure 10. Set of field target faces for a field archery round. (*Courtesy of Fred Bear.*)

the bow can be shot with either end up. Osage flight shooting bows are usually 4 feet to 4 feet 6 inches in length. In field shooting (a form of target archery in which archers shoot at animal silhouttes that are placed in wooded terrain), bows that are slightly heavier than target bows are used (see Figure 10).

It is very important that beginners, regardless of sex, learn on a light bow. Bows that are too heavy at this stage of learning cause tension and the development of poor shooting habits. They detract also from the enjoyment of the sport. Bows as light as 7 to 10 pounds may be used to teach beginners the correct method of draw.

Relative arrow and bow lengths as used by the individual are indicated in Table 3. The official rules for target tournaments specify

Table 3

ARROW-BOW PROPORTIONAL LENGTH MEASUREMENTS[2]

Arrow length	*Bow length*
28″	5′6″
27″	5′6″
26″	5′6″
25″	5′3″
24″	5′
18″–20″	4′6″ (Junior size)

only that points of aim or bow sights may be used for aiming, and that any type of bow except a cross bow may be used.

As a general rule a bow should not be drawn without an arrow in it. It may be overdrawn, causing the bow to break, or causing the limbs of the bow to be broken down which makes the bow lose cast. A bow should never be drawn with or without an arrow in it if someone is standing in front of the bow. If the brow breaks, all of the pieces usually fall forward.

Worn bowstrings should be changed *before* they break, as very often the bow breaks when the string does.

Bows that have been stored or kept in a warm or dry place or that have been unused for some time should be worked in gradually by placing the belly of the bow (at the handle) under the instep of the foot, then gradually drawing the string to the required arrow length, easing up the string to the braced position frequently before coming to the full draw. Frequent inspection of bows for cracks, worn strings, and fistmele is important.

When the bow is braced ready for shooting, the measurement from the belly of the bow to string should be about 6 inches. This can be measured roughly by placing the fist down on the belly of the bow with the thumb extended toward the string. The tip of the thumb should just touch the string or come within ½ inch of it. This is called the fistmele.

Keepers on bows are dangerous. Keepers are strings fastened to the top of the bow and through the loop of the string. If a bow with a keeper breaks, it will usually force the top part of the bow to fly back and hit the archer in the head or face.

[2] A 5 foot 9 inch bow is sometimes used with a 29 inch arrow. Well-constructed bows of 5 feet 6 inches will take a 27 or 28 inch draw safely. However, some archers use a 5 foot 9 inch bow with arrows of these lengths. Some children use a 4 foot 6 inch bow with a 21 inch arrow.

Bowstring

A good bowstring must be strong, resistant to fraying, flexible, and must not stretch. For many years the best strings were made of linen or hemp, particularly Belgian hemp. The loop was hand woven, reinforced, and hardened with glue. Hand-spun domestic flax strings sized with beeswax were a close second to the imported strings in quality and performance. Irish flax thread is also exceptionally strong and can be obtained from the local shoeshop. Barbour's #12

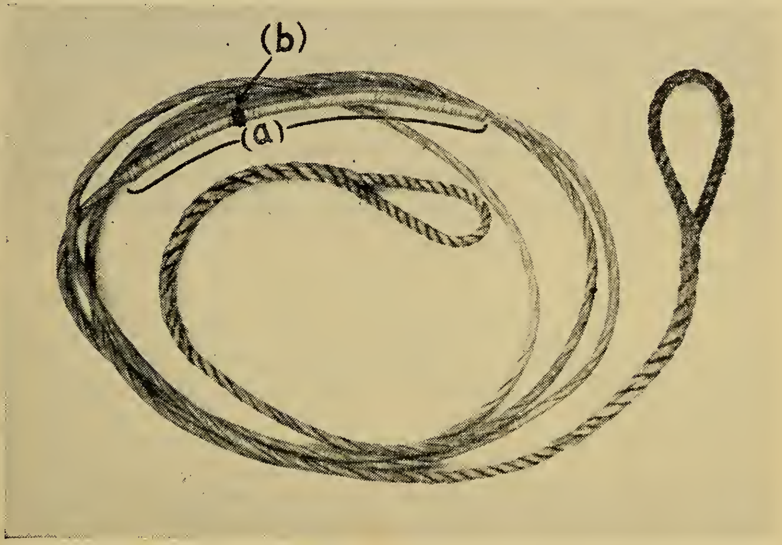

Figure 11. Bow string (double loop) showing: (a) serving, and (b) nocking point. (*Courtesy of Fred Bear.*)

thread is recommended. Strings that are treated with latex (rubber) do not require waxing, and will not fray. The comparatively recent development of plastic strings, notably fortisan, has introduced a bowstring that, in the opinion of many archers, surpasses the linen thread, since it is both stronger and lighter. However, linen stringing will stand more abuse. Metal strings are becoming popular, but are dangerous. If the left arm is held incorrectly, the elbow joint may be hit with the string on release and cut badly.

The cost of strings varies with the type, quality and length of the string selected, as well as with the method of construction. Handmade strings and reinforced loops are more expensive than machine-made strings, which are not reinforced at the loops. Strings are cheaper by the dozen.

LOOPS. Loops should be reinforced as they must withstand the pull, and the wear and tear of contact with the nocks. For bows of 30 pounds and over, double loops are recommended (see Figure 11).

When ordering strings, specify the bow weight and the length of string desired. Length is the distance between the bow nocks measured along the back of the bow. It is recommended that 5 foot 6 inch single loop strings be used. Six foot strings are recommended if the strings are to be used for bows of varying length. These strings can be adjusted for correct length at the lower nock. If this is done, the serving must be extended to go beyond the nocking point. The size string that is used varies with the bow weight and the material used for the string.

SERVING. Each bowstring is served; that is, it has a winding of thread or cord around that part of the string opposite the handle. The arrow fits on the string at the nocking point which is marked on the serving, directly opposite the top of the bow handle.

Target

In a good target only the foreshaft of the arrow penetrates the straw. The target must be firm and compact, and should rest on a softwood tripod that has bevelled edges to prevent injury to arrows that hit the wood. If a soft pine wood is used, bevelled edges are not necessary.

Official rules for target tournaments specify that targets shall be

a. Of standard size 48 inches in diameter, divided into a central disc, 9 3/5 inches in diameter, and four concentric rings, each 4 4/5 inches in width painted respectively from within out, gold, red, light blue, black and white.

b. In sufficiently good condition so that arrow will not pass through them.

c. Set on standards of soft wood.

(Note—Targets of baled straw may be built up from the ground and not placed on a standard.)[3]

OUTDOOR RANGE. The center of the target (regulation 48 inch size) should be 48 inches from the ground. A rope from the back of the target is drawn tightly to a stake fastened in the ground to keep the target from being blown over. A baled straw backstop may be used but should be covered with a waterproof cover and protected from insects, mice and fungi. Bales of straw are set on top of one another

3 "Official Rules for Target Tournaments," *Official Individual Sports Guide*, 1950–52, p. 21.

and may be interchanged throughout the season to distribute wear and tear. This type of target is considerably cheaper than the regulation, round, portable style.

INDOOR RANGE. A regulation 48 inch target or a 36 inch (3/4 regulation size) target may be used on an indoor range. Place the tripods on rubber mats to prevent slipping. A backdrop of three or four layers of burlap with 3 or 6 inches between each layer serves to stop missing arrows. The curtain should hang loosely. It may be arranged with pulleys so that it can be rolled up when not in use. A heavy wool felt back drop, 6 feet wide, 9 feet high, and 3/8 inch thick, is ideal for all indoor shooting. It can be raised and lowered with pulleys, and will last indefinitely. If space is available, use a baled straw backstop. The straw may be covered with burlap. Paper or oilcloth faces may be used by pinning or stapling them to the backstop. When shorter distances are shot indoors, mount 16 inch, 24 inch, 36 inch or 48 inch target faces on target butts regardless of the size of butts. A 30 yard range with a 24 inch target face is quite comparable to shooting at a 60 yard range into a 48 inch regulation target; a 20 yard range with a 16 inch target face is quite comparable to shooting at a 60 yard range into a 48 inch regulation target.

Top quality targets are made of full-length rye straw. A good handsewn target is excellent and costs more than those that are machine stitched; but the latter type are, on the whole, better. Tarred sisal twine is the best twine for stitching targets. If installed properly, replaceable centers are serviceable.

The most durable target faces are made of cloth (muslin). These may be flat or have a drawstring closing that enables the target face to fit smoothly over the target. This style closing is more expensive than the flat type target face. Cheaper faces are made of paper. Colors should be dull to prevent glare. Cost of shipping targets is less if the order aggregates 100 pounds or more.

Armguard

Armguards that protect the bow arm from injury by the bowstring should be worn by all archers (see Figure 2). Guards are available in regular and junior sizes. The latter size is made expressly for young archers and costs less than the regular size. Top quality guards are made of cordovan leather and should be interlined for moisture absorption and protection against sting or bowstring. An excellent feature of many guards is a steel reinforcement that is usually placed between the leather and the lining. Attachment of guard to the arm may be by such means as snaps, laces and hooks, straps and buckles, or elastic straps. The latter type is adjustable to varying arm sizes

but requires replacement of the straps when the elastic is worn out. Plastic armguards are becoming popular, but they are not quite as pliable as leather, they can break, and become very hot when exposed to the sun for any length of time.

Shooting Glove and Tab

For protection of the fingers, a shooting glove or tab should be worn on the drawing hand (see Figure 12). Top quality gloves and

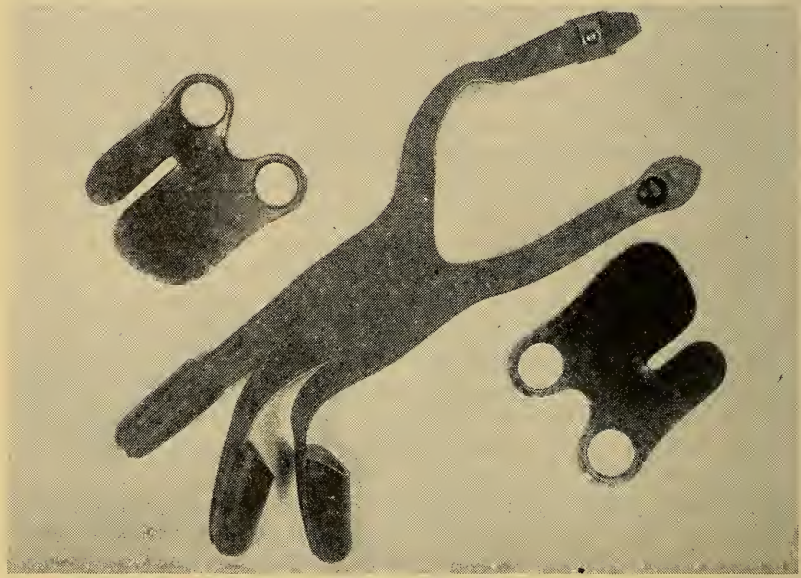

Figure 12. Finger tabs and shooting glove. (*Courtesy of Fred Bear.*)

tabs are made of cordovan leather which is ideal because of its smoothness. The all leather glove with cordovan tips is preferable to other styles, since it is more flexible and moulds to the hand. These include soft cowhide tips with backs and straps of elastic or plastic. Cowhide is not as smooth for release as cordovan. Straps should be adjustable. Sizes range from small to large; specify size when ordering. Tabs may be trimmed to adjust to individual specifications. If holes are too small, this portion of the tab may be soaked in warm water for a few minutes and stretched to desired size. Tabs are made for both left and right hands. It is advisable to break in a new glove by soaking and then shooting to mould the glove to the hand.

Quiver

Quivers may be of the belt type made of leather, imitation leather or plastic. Ground quivers often have an attachment to hold a bow. These quivers stick into the ground and are excellent for class use. Floor quivers serve the same purpose for indoor use. These may have a tubular disc or square wooden base 6 to 10 inches square.

Bow Case

Canvas, leather, imitation leather, oilcloth and other materials are used for bow cases. The material should be soft and waterproof, preferably with a slide fastener at the opening (top) for removal and replacement of bows. Cases carry one, two or three bows.

Bow Sight

Simple bow sights are the most practical. A black-headed pin inserted in a piece of adhesive placed on the bow back is serviceable and inexpensive.

Target Covering

Target coverings should be waterproof and large enough to protect the entire target from rain.

Arrow Tassel

Arrows that miss the target are wiped clean with wool yarn tassels.

Points of Aim

Any object that can be inserted in the ground and seen by the archer from the shooting line will serve as a point of aim. This may be a golf ball with a long nail driven through it, or a block of wood one inch to 1½ inches square. The object should be small enough for accurate aiming but big enough to see clearly. A white object is the most visible.

Bow Rack

Individual metal bow racks 7 to 8 inches tall can be inserted in the ground for outdoor use. These are surmounted with cross pieces of heavy wire or other smooth material on which bows may hang.

Costume

Archery is an outdoor fall and spring sport, except when archers use indoor ranges during winter months or during inclement

weather. On the whole, the costume should be cool and comfortable, especially the upper part of the garment, since it is here that the strain of drawing the bow is felt. Skirts should be wide enough to permit an easy stance when shooting, and comfortable walking stride when recovering arrows. They should also be suitable for wear during windy weather. Very loose garments may be a distraction on a windy day if they flap in the breeze, or, in the case of dresses and shirts, if they fly up and catch in the bowstring.

All items of general sportswear, with few exceptions, are suitable for wear when engaging in target shooting. These include sweaters, shirts and slacks for men (see Figure 7), and sweaters, blouses and skirts, or sport dresses for women (see Figure 6). The wearing of sweaters is, of course, optional and depends to some extent on the weather. T-shirts are ideal for both men and women. Some women prefer sleeveless dresses, and in warm weather sun-back dresses are popular. Shoes with low, flat heels are also suitable, and permit better balance. Length of hose, anklets or stockings for women, half-hose or socks for men, are matters of personal preference. The exceptions mentioned above include the following: the top of the costume should be comfortable but not loose, and plain so that there will be no interference with the bowstring that would result in torn clothing, interfere with aiming, or cause injury. Sleeves should be cuffless and close fitting without being binding. White is traditional, especially for wear during tournaments.

Care And Repair[4]

The following are suggestions for the care and repair of arrows, bows, bowstrings, targets, armguards and finger tabs.

Arrows

1. Keep arrows in racks or boxes which have at least two sets of holes, one directly under the other, in order to keep the arrows perfectly straight. Allow enough room between each arrow so that the feathers do not touch (approximately 6 inches). Indicate the arrow length on the rack. Adhesive tape makes a suitable marker.

2. Use steel wool for cleaning wooden arrows, then wax the shafts. This makes the arrows easier to draw out of the target, maintains a smooth finish, and protects the arrows from moisture.

3. Examine the pile end of the arrow if it has hit a hard object, and sandpaper the wood to a smooth finish before shooting again.

[4] Most of the suggestions listed here are contained in mimeographed material distributed at the Teela-Wooket Archery Camp. For additional information write to Mrs. Myrtle K. Miller, 450 West 24th Street, New York 11, New York.

Rub the metal piles with oil to prevent rusting. Check the arrows for splinters. It may be possible to repair minor splits and cracks if cement can be put on both broken edges and the break bound tightly with strong thread. When the cement is thoroughly dry, remove the wrapping and sandpaper any rough edges. Care should be taken to see that the shaft is perfectly straight before and after it is wrapped. Arrows broken at the pile end can be cut off, shortened, and new piles applied.

4. Straighten an arrow by placing the shaft over the heel of the hand and bending it in the opposite direction. Arrows may be straightened in this manner by heating over a hot plate, but never over an open flame.

5. Remove a broken pyroxylin nock by means of a lighted match, then smooth the wood with sandpaper or fine steel wool, and apply a new nock with a very thin coat of quick drying cellulose cement. Too much cement will soften the plastic. The nock should be perpendicular to the cock feather.

6. On a wet day, collect first those arrows that are on or in the ground, then those in the target.

7. Wipe with a tassel those arrows that are retrieved from the ground in order to protect the bow at the arrow plate, as well as the arrow.

8. Steam slightly and smooth out arrow feathers that are pressed out of shape. A loose feather can be cemented in place with thread until the cement is dry. Be sure the feather is correctly aligned when it is tied in place.

9. Cement loosened piles and nocks that were originally cemented to the shaft. If preferred, arrows can be returned to the manufacturer for these repairs as well as for refletching, recresting, repolishing, and straightening. New piles can be applied by the individual archer, but it is preferable to return the arrows to the manufacturer for this purpose or to have it done at a reputable tackle shop.

10. Remove arrows from the target, touching them only at the pile end with the thumb and first and second fingers. The shaft should be free from contact, then draw the arrow straight out. To draw arrows from the ground, the arrow should be held with thumb and forefinger at the point where it meets the ground, and drawn straight out at the same angle that it entered the ground.

11. Avoid bumping or touching other arrows in the target that are not being drawn.

12. Carry arrows by the pile end. If held at or near the fletching, the feathers may be damaged.

13. When storing arrows after seasonal use, put them in arrow

racks in a closed box or similarly protected storage space. Protect the feathers from moths with any good moth preventive.

Bows

1. Ideally, bows should be supported in a horizontal position, with the supports either toward the ends or toward the middle of the bow. If the supports are near the end of the bow, place the belly of the bow down; if the supports are near the middle of the bow, place the back of the bow down. As an alternative method of storing bows of medium quality, hang the bow vertically on pegs by a string drawn through the hole in the upper nock, or hang the bow with a peg between string and bow so that the bow does not touch the floor. Never place bows on the floor or ground.
2. Indicate clearly the tops of bows by painting arrows or similar marking on the belly of the bow.
3. Protect the finish of the bow with wax.
4. Weigh bows frequently on ice scales, and measure the draw with a yard stick.
5. Number the bows systematically, one, two, three, and so forth, the lightest to the heaviest bow. An alternative method of marking is to indicate the weight on each bow. Place a letter on each bow for purposes of identification.
6. Advise archers to shoot with the same bow until ready for a heavier one.
7. Number racks or pegs on which bows hang.
8. Keep bows on standards or bow racks when they are not in use in class.
9. Straighten bows that have taken a set by steaming. If a bow does not straighten when unbraced, it is said to have taken a set. Never bend a bow backwards in an effort to straighten it.
10. Unbrace bows when the shooting is finished.
11. In cold weather flex the bow gradually before putting it to a full draw. Cold affects wood and the bow may splinter if drawn too quickly to full draw.
12. Wash the grip occasionally with soap and water to remove perspiration and dirt. An occasional use of disinfectant is also advisable.
13. Oil the leather grip occasionally to keep it from drying out and cracking.
14. Send bows to the manufacturer for any major repair.

Give metal bows the same care except for those items of care that are directly related to wood. The steel should be protected from

rusting by wiping dry and oiling. Care should be taken so that the bow is not subjected to salt spray. Aluminum bows should be protected from soap and any alkaline substances.

Bowstrings

1. Replace badly frayed strings. If only one or two strands are broken, cut them off and wax the string.
2. Wax strings that are not latexed or that are not metal by rubbing in the wax with brown paper. Rubbing gives heat that melts the wax. Use beeswax on the string and paraffin on the serving. Some archers prefer to use a cement on the serving to harden it.
3. Mark the nocking points and replace worn servings. No. 4 store string, dental floss or carpet thread are suitable for serving.
4. Tie a timber-hitch in a single loop string at the lower nock.
5. Check the bracing height by fistmele or by measuring 5½ to 6 inches on a 5½ foot bow, or 7 inches measured from the back of the bow. In retying the timber-hitch, the straighter the bow the farther down the bow the loop will be. Shorten the string by retying the timber-hitch ½ inch or more near the loop. The string can be twisted slightly to shorten it in an emergency.

Targets

1. Cover adequately with a waterproof covering targets that are left out overnight.
2. Varnish the target stand occasionally for protection of the wood against moisture.
3. Replace worn and weakened tripod legs.

Armguards and Finger Tabs

1. Oil the leather occasionally to keep it from drying out and cracking.
2. Dry clean the leather armguards at least once a year.

CHAPTER II

Baseball and Softball

BASEBALL

Early in the nineteenth century Americans played a bat and ball game known as Old Cat. Players took positions so as to form a rough square with a pitcher and a batter at each corner or base. It was not long until a new version evolved, known variously as The Massachusetts Game or Town Ball. The square playing field was retained, but the players were now divided into teams of fifteen or more players. The teams alternated at batting and fielding. The pitcher for the fielding team made his delivery from a point in the center of the square and the batter took a fixed point, midway between two bases.

By 1846 the early forms of baseball had been modified and more closely resembled the modern game. Just who originated this new change is a matter of controversy. Many authorities attribute it to Abner Doubleday, while others give credit to Alexander Cartwright. A third group points out that as early as 1787 there was a poem written, entitled *Base-Ball*.

Up until 1866 many types of balls were used, but in that year the first standardized baseball was manufactured. Its specifications called for a ball not less than 9 nor more than 9¼ inches in circumference and weighing not less than 5 nor more than 5¼ ounces. Those specifications, written in 1866, are still in effect. Today there is a

recurrence of newspaper and magazine publicity concerning the "rabbit ball" (one that is extra lively). The first mention of the lively ball dates back to 1870, but the method of manufacture of a baseball has not changed greatly since then. In 1910 a cork center was substituted for the rubber center.

Equipment

Balls	Jackets	Uniforms
Bases	Leg guards (catcher)	shirt
Bats	Masks	pants
Body protectors	Shoes	cap
Gloves and mitts	Sliding pads	hose
		jacket
		shoes

Ball

The term "official" is overused perhaps more with baseballs than with any other single piece of athletic equipment. In a check of twenty-four baseballs of different trade-names—regardless of price, method of construction or materials used—each was stamped *Official.* In this sense official pertains only to size and weight and does not imply quality, durability or performance.

LEATHER. The leather for the cover should be full-grain alum tanned horsehide-fronts. Occasionally kipsides or sheepskin is used. The latter cannot be classified as durable because the collagen (leather-forming) fibers are extremely thin and not closely interwoven. Sheepskin can be distinguished from horsehide or kipskin in two ways: it scratches easily and it feels spongy rather than tight and firm over a baseball.

The tannage should be sufficiently firm to prohibit loosening of the cover in normal play or excessive dampness. Because alum tanning completely changes the color (to white) of the leather, it is difficult to ascertain some defects; but the covers should have no cuts, scars, or loose fiber. It is not advisable to select baseballs on which the grain of the leather has been corrected by action against an emery wheel or some other abrasive (see Leathers, pages 299–304).

COVER THICKNESS. The two hour-glass shaped pieces of leather used for the cover must match in thickness before processing, and should be shaved to .055 of an inch. A cover just 10/1000 of an inch thicker will shorten the distance of a hard hit ball at least 75 feet.

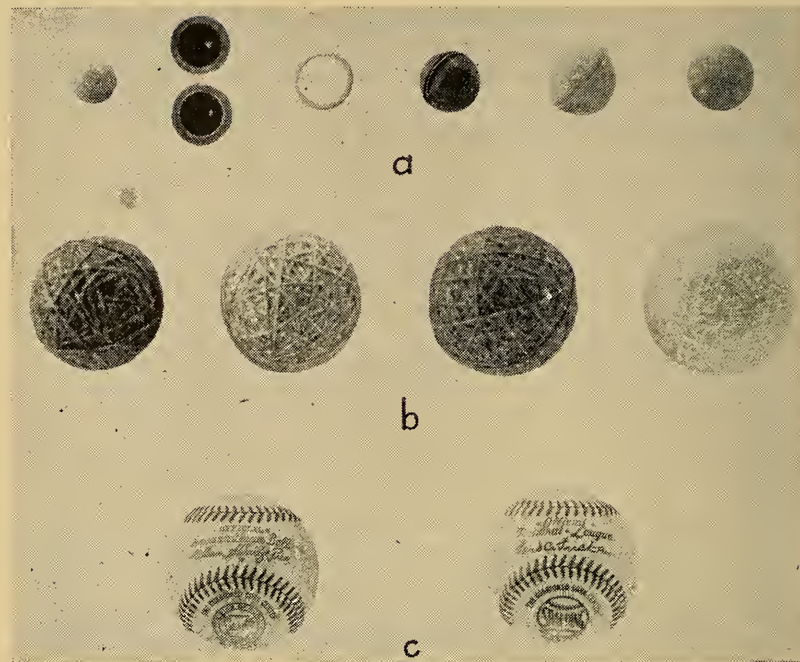

Figure 13. Processes in the construction of a baseball: (a) building the cushioned-cork center, (b) applying four types of yarn, (c) the finished product. (*Courtesy of A. G. Spalding and Bros., Inc.*)

CENTERS. Three types of centers are used in the construction of baseballs. Cushioned cork (natural, not synthetic), because of its greater resiliency, is used in most top grade balls (see Figure 13). A combination cork and rubber center is used in the medium price range, and solid rubber (natural, not synthetic) is used for less expensive balls. All three centers are the same size, approximately 1.36 inches in diameter.

YARN WINDINGS. The method of winding yarn around the center is usually the same for all types of baseballs. It is the materials that differ. The minimum quality of yarn used for a top grade ball should be at least 98 per cent wool, of which not over 25 per cent should be reworked wool. It is possible for a ball to be sold as one wound with all wool, yet with very little of the yarn of top quality wool. Reworked yarn loses much of its resiliency during the process of cleaning. It is difficult for the lay person to discover greasy wool without a laboratory examination, but balls wound with wool containing

a high grease content (more than one per cent) should be rejected. Grease causes the fibers and strands to slip easily, and the lightest blow will leave a flattened surface or a lopsided condition.

Three- or four-ply yarn is more resilient and more durable than two-ply yarn. Top quality balls are usually wound with three- or four-ply; less expensive balls, with two-ply yarn. Top quality and medium priced baseballs usually have four windings; the least expensive, usually less than four.

Where there are four windings, the first one (nearest the center) should be rather coarse, about 500 yards per pound. The second should be less coarse, about 850 yards per pound; the third, rather fine, about 1000 yards per pound; the fourth may be a very thin layer, called the finishing layer, of cotton or wool.[1]

GENERAL CONSIDERATIONS. When inspecting baseballs or checking an order of balls, examine for the following:

1. Leather cover—for breaks in the grain; cuts, loose fiber, corrected grain, sponginess; large spots and stains; broken stitches or needle holes.

2. Seams—for edges of cover which do not meet by more than 1/16 inch; loose tension; uneven and broken thread; thread not securely anchored.

3. Circumference—which should be not less than 9 inches nor more than 9¼ inches.

4. Weight—which should be not less than 5 ounces nor more than 5.35 ounces. (This is 1/10 ounce more than regulation weight, but the deviation allows the purchase of "seconds" for practice or intramural games.)

The price of a baseball depends primarily upon three things:

1. Center. Cushioned cork, most expensive; cork-rubber combination, medium priced; and solid rubber, least expensive.

2. Yarn. Three- or four-ply, most expensive; two-ply, less expensive.

3. Cover. Top quality horsehide, most expensive; kipskin and sheepskin on others[2]

Bases

Bases should be made of the best grade duck material with a minimum weight of 18 ounces per yard. Depending upon frequency

[1] United States Office of Quartermaster General, *Baseballs,* November 28, 1947, p. 3.

[2] United States Office of Quartermaster General, *Baseballs,* August 1, 1946, pp. 4–6.

and severity of use, 33 ounce duck material may be more economical.[3] Professional leagues use 42 ounce material with 1¼ inch sponge rubber layer, stuffed with wool and cotton filler.

Regardless of material, bases should have double-thickness tops and be united by quilted sewing. There should be a leather reinforced tunnel opening for the strap (see Figure 14). The strap should have an adjustable buckle fastening and be made of 1½ inch heavy

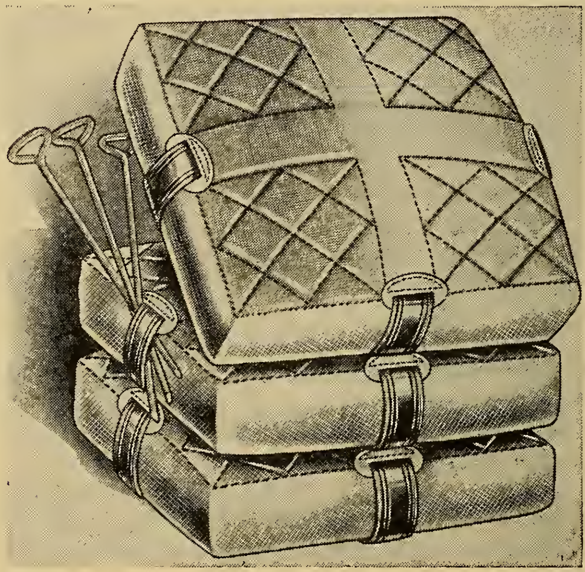

Figure 14. A set of official baseball bases. (*Courtesy of Rawling Manufacturing Company.*)

web. Bases may have either one or two spikes per base. Excelsior stuffing is adequate for most playing conditions; wool and cotton are used for more expensive bases.

Bat

The first regulation regarding bats was written in 1863. At that time bats had to be round, made of wood, could not exceed 2½ inches in diameter and had no restrictions as to length. In 1876 the length of the bat was limited to 42 inches; in 1895 the diameter of the bat was increased to 2¾ inches. In 1940, for the first time in forty-five years, the rule was changed once more. Now it reads:

3 United States Office of Quartermaster General, *Bases, Baseball,* December 21, 1943, p. 1.

The bat must be round, not over 2¾ inches in diameter at its thickest part, nor more than 42 inches in length and entirely of hardwood in one piece. Twine may be wrapped around it or a granulated substance applied to it for a distance of 18 inches from the end of the handle, but not elsewhere.[4]

MATERIALS. Bat manufacturers have found that second growth ash meets the requirements of ball players most satisfactorily; it has the tensile strength required, the resiliency, and can be obtained in fairly light weights. The best ash comes from northern hillside slopes which hold water, where the growth is moderately fast and constant and the growth of other trees is thick. This protects them from wind-twisting and forces the ash trees to shoot straight up in their battle for sunlight. Some sections produce fine ash, as far as quality is concerned, but it is too heavy for use in the modern bat—that is, too heavy to make bats that can be used successfully by the modern type batter.

Some hickory is used for bat making, but this wood has the disadvantage of being slightly on the heavy side. Several years ago, bats made of Cuban wood, or Majaya, were popular, but the cost of obtaining this wood was excessive and its use as bat timber was discontinued. Some hackberry is used, where extremely light bats are required; but this timber lacks the resiliency and solidity of ash and there is a limited demand for it. Willow is used most often for fungo bats, primarily because it is very light, quite resilient and still as tough as many hardwoods.

STYLES. Ball players and bat manufacturers recognize a few characteristics where bats differ. Thus, while the rules state that a bat may be 42 inches long and 2¾ inches in diameter at the largest part, many variations are possible. A bat in ball players' language may have a big end or a small end; a quick taper, which limits the space where the ball may be struck, or a gradual taper, which increases that space; and a small, medium, or large handle, with a small, medium or large knob. There can be any combination of these characteristics a player desires.

In the past there were fewer differences in bats than at present. The average bat of 1925 had a medium barrel with a gradual taper to a medium large handle and small knob. This type of bat provided the player with the near maximum of hitting space and normally weighed 37 to 40 ounces. The present trend is toward a bat 35 inches long, weighing within an ounce or two of 35 ounces,

[4] National Baseball Congress, *Official Rules for Baseball,* 1950, p. 3.

with a small hitting surface and slightly more than 2½ inches in diameter at the largest part of the barrel.

The modern style bat, which has a small or short hitting surface, limits the effective hitting surface to a space not more than 8 or 10 inches from the end of the bat. Such a bat satisfies the modern free-swinging style of baseball, but calls for much greater accuracy and sharper vision than the old style bats required. Adoption of the new style of hitting and consequently of the new type of thin handle, large barrel bats, with a short hitting surface, was a challenge to bat makers, for breakage was increased by the thinner handle, by the concentration of weight at the barrel end, and by the lighter weights required for free-swinging. Formerly, players were advised merely to hold the trade-mark up, since any bat might be broken that was held improperly; now they are advised to hit the ball on the exact space provided. Any ball hit on the extreme end or too near the handle of a modern bat may put too much of a strain on the wood and result in a break.

Bat makers further discourage the use of long bats that increase the strain which a full blow puts on a bat. They recommend that the average player use a bat 34 or 35 inches long, weighing at least an ounce to an inch, and concentrate on accurate hitting instead of going in for long lengths and wild swings. This trend is borne out by the bats used by professional players today. A recent survey of 217 models used by players of the two major professional leaguers showed that 88 per cent were 35 inches or less in length. The breakdown: 6 per cent were 33 inches long, 26 per cent were 34 inches long, 56 per cent were 35 inches long, and 12 per cent were 36 inches long.

Bat manufacturers have withdrawn policies of guarantee on all bats. It has been suggested that the high rate of breakage of the past few years has been due to bat style. However, wood experts outside the bat industry have suggested additional causes: lack of proper wood inspection methods; and improper drying processes.

A guiding factor in any selection of wood or wood products is the experience and integrity of the manufacturer and his personnel of graders and inspectors. Only rarely do individual coaches have the opportunity to inspect the raw wood before it is made into bats. To compensate for this, the consumer should know something about the reliability, integrity and honesty of the company from whom he purchases bats.

Improper artificial or kiln drying often causes bats to break. Drying by means of electric kilns has decreased the period of seasoning from a minimum of nine months for loft drying to two or three weeks for kiln drying. Wood chemists agree that a great deal of skill

and knowledge is needed to withdraw moisture artificially from the raw lumber. The temperature must constantly be checked against the moisture content. When the heat is too intense rapid evaporation occurs and brashness often results. A bat made of brash wood will usually break into two pieces, the break being jagged but perpendicular to the grain and usually 4 to 10 inches from the handle end. Such a break is usually due to a very coarse and porous cell structure where the moisture may have been withdrawn too rapidly and the cell wall left brittle.

SELECTION. *Size and weight.* For most school and college players the bat lengths should be 33, 34 or 35 inches. For weight the average player should allow one ounce per inch with 36 ounces the top weight. Hughes writes the following:

> There is an excellent reason why most players should adopt bats 35 inches or less. Those who insist on long light bats overlook the important factor of balance. Many players believe they can swing a long, light bat better than a short, relatively heavier bat, thereby getting longer distance. Just the opposite is true, however, for a shorter and correctly balanced bat can be swung faster since the speed of the bat and the resulting impact on the ball is a result of wrist snap. The player with strong flexible wrists can handle a heavier and longer bat than the player with weak, inflexible wrists. It should be emphasized, however, that correct balance has nothing to do with overall weight. The swinging or leverage weight is the controlling factor. For example, a 35 inch bat weighing only 34 ounces may have a heavier swinging weight than a 34 inch bat weighing 36 ounces. This is an important point for every . . . ball player.[5]

High school players, college players and members of amateur and semiprofessional teams often copy the professional players in selecting the style of bat used. They should be advised, however, to inspect the bat for straight-grain, wood defects, type of wood and other characteristics which affect the durability and performance of a bat before purchasing an autographed model.

Approximately 6,500 bats (and 9,000 dozen balls) are needed each year for the two major professional leagues; perhaps another 10,000 bats, for the minor professional leagues. Because of direct contacts with bat manufacturers, these players get their choice. The remaining bats are issued to retail and wholesale dealers for distribution to school and local teams. Thus careful inspection is essential in order to secure the best bats.

[5] W. L. Hughes, *The Book of Major Sports,* 1938, pp. 279–280.

Quality. Two grades of baseball bats usually are available on the market. The Grade One bats are professional name models of the highest quality. Grade Two may be, but need not be, professional name models. Special treatment of the wood also affects the quality.

1. Grade One bats (see Figure 15). These top grade bats should be made from ash, hickory or hackberry wood in that order and then only when the latter wood is of equal quality as the ash. The wood can be either heartwood or sapwood, and should be properly and uniformly seasoned with a moisture content of not less than 10 per cent nor more than 18 per cent.

The lateral deviation of the grain should be not more than one in thirty-five for a distance of 15 inches measured along the bat toward the butt end and starting the measurement 4 inches from the knob end of the bat. In portions of the bat other than the critical area, which is an area 10 inches long beginning at a point 4 inches from the knob end, sound knots not over 1/8 inch in diameter are permissible. Within the critical area two sound knots not exceeding 1/16 inch in diameter shall be permitted provided both do not extend through the bat and are not closer than 3/4 inch measured center to center. There should be no loose knots, machine tearouts, flat surfaces, spiral grain or plainly evident splits and shakes (see Woods, pages 304–310).

Figure 15. A top quality, grade one autographed bat. (*Courtesy of Hillerich and Bradsby Company.*)

2. Grade Two bats. Ash, hickory or hackberry in that order are preferred for Grade Two bats. The lateral deviation of grain shall be not more than one in twenty-five for a distance of 15 inches measured along the bat toward the butt end and starting the measurement 4 inches from the knob end of the bat. In portions of the bat other than the critical area, sound knots not over 1/4 inch in diameter are permissible. Within the critical area four sound knots not exceeding 1/16 inch in diameter are all right, provided that no knots are closer to each other than 3/4 inch measured center to center of knots, and not more than two extend through the bat. Bats should have no loose knots, machine tearouts, flat surfaces, or decay holes.

3. Finish. Grades One and Two bats should be sanded to a smooth surface, may be filled with wood filler, and may be natural or uniformly stained. The stain should not obscure the figure or grain of

the wood. The bats should be finished with a coating of clear lacquer or with a coating of spar varnish. The finish should be smooth, uniform, without variation as to gloss, and should not be tacky. The finish must be free from dirt and other foreign material.

4. Special Treatments. The bats may be given special treatments with the object of improving resistance to chipping, hardening the surface, or similar objectives when the treatment does not affect serviceability of the bat. No bat should be loaded with metal or other foreign substance to increase the weight of the bat. Tape or other material or substance may be applied to the bat for improving the batter's grip, but should not extend more than 18 inches from the knob end of the bat. The largest diameter of the bat must not exceed 2¾ inches.[6]

Traditionally, all baseball bats have been made of wood in one piece, but advances in science have caused innovations in the manufacture of bats. Players who have used laminated or aluminum bats report that they do not split and that there is no appreciable difference between these bats and wooden bats.

MAKING BATS. Schools or individuals who have access to the necessary woodworking equipment may want to make their own bats. As suggested earlier, ash or hickory woods are suitable if carefully selected. The wood must be hard, close and straight grained and free of loose knots. Woods with coarse textures or heavy grain are usually weak and brash. If properly dried, both will be tough; if kiln-drying is unduly forced, the wood will prove unsatisfactory. The specially selected comb-grain (straight and fine) stock should be roughed out and stored in a warm dry place for at least six months. Then it should be rough-turned to within approximately ¼ inch of the desired size and stored for another three months before the bats are finish-turned. This is important in order to avoid the flattening which occurs when bats are finish-turned the first time in the lathe.

There are two recommended methods of finishing baseball bats made of ash or hickory. After the bat has been turned and is still in the lathe, coat it with a wood filler rubbed in while the bat is turning at 600 revolutions per minute. This can best be done by means of a heavy strip of cloth held stretched in both hands so that the center portion bears down on the bat. Allow the filler to dry overnight and then varnish with a single coat of dull or gloss, four-hour varnish. Allow the varnish twenty-four hours to dry in a warm room. This method can be varied by using colored fillers for decorative purposes, followed by varnish.

6 United States Office of Quartermaster General, *Bats, Baseball,* June 23, 1945, pp. 2–4.

A second method of finishing uses a large Bunsen burner with an oxidizing flame tip to burn the bat in flashed areas, again for decorative treatment. Sanding with 6/0 paper should follow, then filler and varnish as above. On some woods a coat of varnish having about one ounce of medium chrome yellow ground color added to a gallon of clear varnish adds to the general tone of the finish.

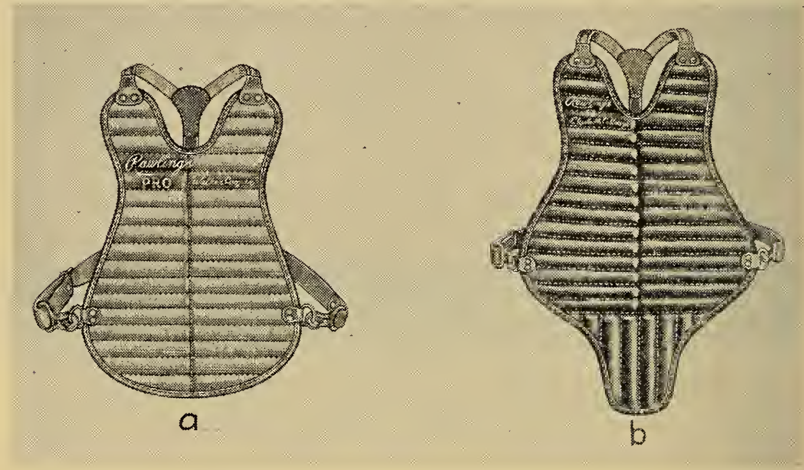

Figure 16. Baseball body protectors: (a) a body protector usually worn in the professional leagues, (b) the model worn most often by catchers playing with non-professional teams. (*Courtesy of Rawlings Manufacturing Company.*)

Body Protector (Catcher)

The body protector should be of the general design used in the professional leagues. It should have a minimum of eleven rolls in body, with a padded extension shoulder. Nine ounce or better water repellent Army duck provides a good foundation material. 100 per cent kapok is the best filler; reclaimed kapok is often used in less expensive chest protectors. The edges should be leather bound (fabric or tape on less expensive models); the back straps should be made of leather, not less than ¾ inch wide; straps should be fastened to body protector by rivets and should be adjustable by buckles. Elastic or nonelastic webbing or leather shoulder straps at top of protector should be not less than one inch wide. It is recommended that high school and college catchers use the model with the extended bottom flap as compared with the shortened protector used by professional players (see Figure 16).

Gloves

There are nearly as many models of baseball gloves as of bats. Many companies retain players and coaches whose names are used on various models of gloves; each autographed model is usually available as long as the athlete is in the public headlines. When selecting a baseball glove, the choice is based on personal likes and dislikes and the position to be played.

When selecting baseball gloves, examine for the following:

CATCHER.

1. Leather for type—full grain, chrome tanned cowhide or horsehide. Cowhide is better since it is softer, more pliable, but also more expensive. Horsehide is more durable and less expensive, but stiffer.
2. Leather for quality—no open cuts, deep scratches, or other defects which might impair serviceability.
3. Leather for oiling—only enough oil to soften the leather. Often the less expensive glove is saturated with oil in order to hide leather defects. The inner palm of the pocket should be greased.
4. Lacing for width—not less than 3/16 inch wide.
5. Lacing for thickness—not less than 1/16 inch wide.
6. Lacing for tension—the palm and back firmly laced together.
7. Eyelets for clinching—securely clinched and all lacing through metal eyelets.
8. Sewing for correctness—all stitches lock-stitched with no broken or missed stitches.
9. Wrist strap for width—strap not less than 2 inches wide.
10. Wrist strap for wool lining—on the underside.
11. Padding for type—felt with at least a 75 per cent wool content for base pad; wool content of at least 60 per cent for remainder of padding. Padding should be even, not matted or wadded. The higher the percentage of wool, the less chance for wads or lumps to form.
12. Padding for shape—hand-lasted leather palm facing formed over a frame or molded for the pocket. The pocket should not be made by shifting the padding.
13. Lining—full leather lined.[7]

FIRST BASEMAN.

1. Leather for type—same as 1 above.
2. Leather for quality—same as 2 above.

[7] United States Office of Quartermaster General, *Mitts, Baseball, Catcher's*, August 1, 1945, pp. 3–9.

3. Seams and stitching for type—stitches lock-stitched. There should be no broken or missed stitches; missed or split welt; or absence of welt.

4. Binding for material—leather (preferably sheepskin).

5. Wrist strap for width—not less than 1¼ inches wide.

6. Wrist strap for buttonholes—at least two buttonholes. The button should be securely fastened. (Note: adjustable lacing may be used.)

7. Lining—a padded lining on the inside of strap.

8. Eyelets—see Catcher.

9. Lacing—see Catcher.

10. Padding—two layers of felt, each containing not less than 70 per cent wool. The total thickness should be ⅝ inch. The glove pocket should form itself on the hand in position for catching ball.

11. Lining—full leather lined.[8]

Figure 17 shows a trapper model glove for first basemen. During the 1949 professional baseball season, there was agitation among players to outlaw the trapper model because of its excessive pocket area. In the trapper model, all finger panels are eliminated and the fingers are placed in an outside panel. Figure 17 also illustrates a new "web-controller" built into the glove to make it conform to the latest rulings of professional baseball. The leather strap across the top of the glove allows no more than the maximum 4½ inch spread of webbing. This new design is official for the major professional leagues for 1950.

FIELDER.

1. Glove for style—a one-piece palm. Less expensive gloves are made from splits (pieces) and joined together, usually around the thumb and fingers.

2. Leather for type—see Catcher.

3. Leather for quality—see Catcher.

4. Binding for material—see First Baseman.

5. Wrist strap—see First Baseman.

6. Seams and stitches—see First Baseman.

7. Trap—not less than two adjustable laced straps for trap between the thumb and first finger. The longest strap should not exceed 4 inches in length. Leather webbing or lacing is often used on less expensive gloves.

8. Padding and pocket—padding of felt containing not less than

[8] United States Office of Quartermaster General, *Mitts, Baseball, First Baseman,* August 6, 1945, pp. 3–7.

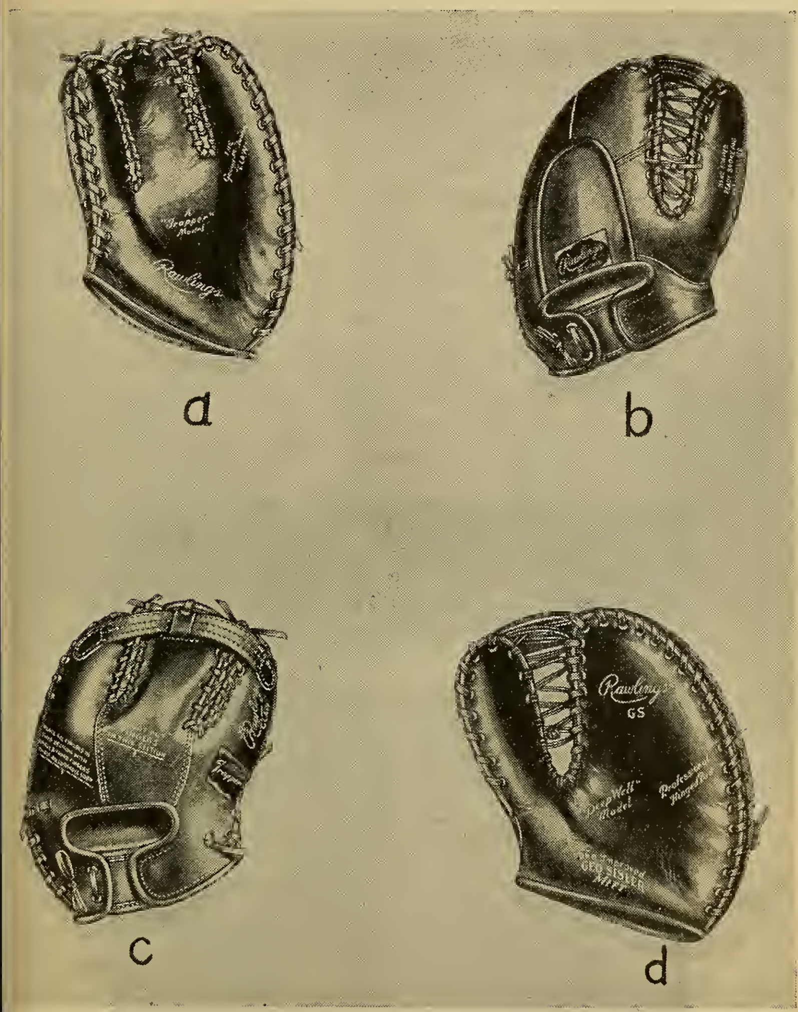

Figure 17. Baseball mitts: (a) trapper model first base mitt, (b) back view of trapper mitt, (c) regulation model first base mitt, (d) back view of regulation model. (*Courtesy of Rawlings Manufacturing Company.*)

50 per cent wool. Less expensive gloves often use quilted cotton padding. The pocket should be well formed.

9. Lining—full leather lined.[9]

[9] United States Office of Quartermaster General, *Gloves, Baseball, Fielder's,* November 27, 1944, pp. 2–3.

Leg Guards

The model and size of leg guards purchased is a matter of individual choice. It does not really matter whether the shin fiber has 3 or 4 rolled corrugations (see Figure 18). When selecting leg guards some of the things to consider are:

FIBER. The fiber should have the stiffness suitable for the purpose and should not be less than 1/16 inch thick. The fiber should be waterproofed by coating with a suitable lacquer or varnish. Most leg guards are red in color, obtained either by coloring the fiber during the processing or by coloring the lacquer or varnish.

PADDING AND STRAPS. The protective padding should be felt, approximately ¼ inch thick. The elastic straps, three to a guard, should be at least one inch in width. The buckles may be the traditional arctic type or any other with quick release mechanism.

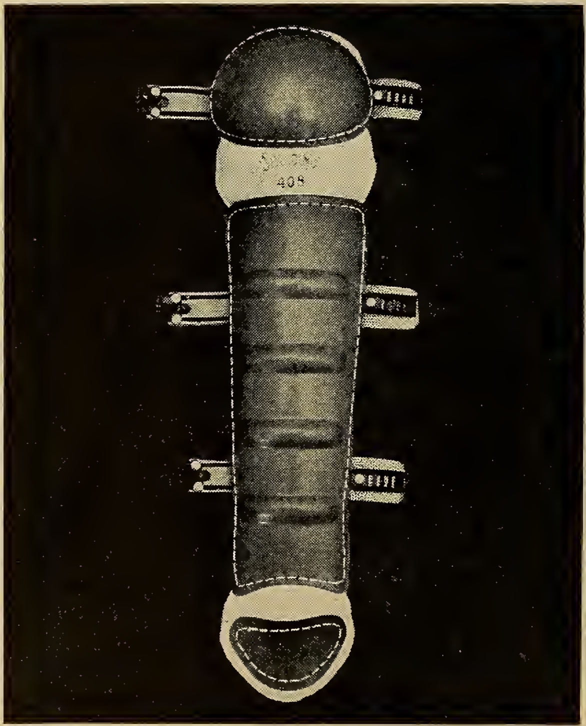

Figure 18. A shin guard with the four-rolled corrugation. (*Courtesy of A. G. Spalding and Bros., Inc.*)

CONSTRUCTION. The guards should be of the general design used in the professional leagues, consisting essentially of three fiber pieces joined with leather connectors, two leather shock absorbers (canvas is used for less expensive models), a hair-filled padding roll between the knee and the skin fiber (padding is omitted on less expensive models), felt lining on leather connectors and three adjustable elastic webbing leg strips.

DESIGN AND DIMENSIONS. There are many variations in design and contour, most of them affording adequate protection. As an average,

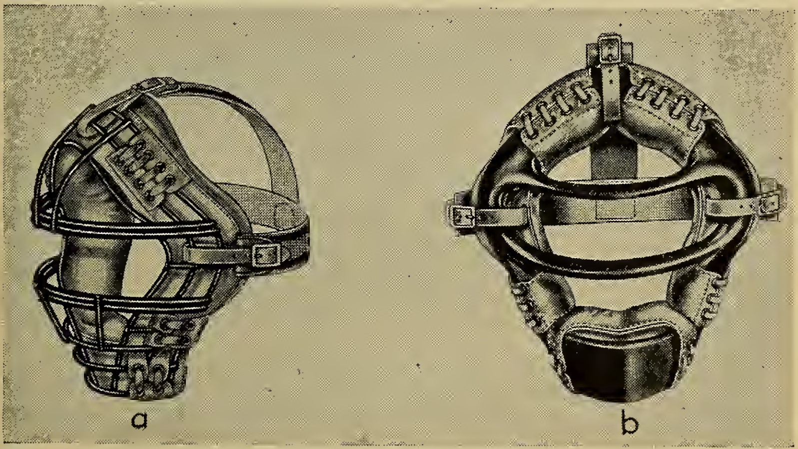

Figure 19. Catchers' Masks: (a) open vision wire frame catcher's mask, (b) magnesium frame mask. (*Courtesy of Rawlings Manufacturing Company.*)

the overall length should be 22 to 23 inches; the width at the top, 6 inches, and width at the bottom, 4 inches. The skin fiber may be riveted or sewn to the leather connectors. However, rivets, when securely set, are usually more durable.

THREAD AND STITCHING. For sewing fiber parts 3 to 6 stitches per inch of 8/5 cotton thread or better is suggested. For sewing binding and knee pad 4 to 7 stitches per inch of 36/6 cotton thread is recommended.[10]

Mask

Catchers' masks come in two styles: the wire frame mask, and the bar mask (see Figure 19). Excluding the metal protection, the construction of both styles is similar.

[10] United States Office of Quartermaster General, *Guard, Baseball, Leg,* February 19, 1945, pp. 2–3.

WIRE FACE MASK.

Construction. The mask may be of any general design, consisting essentially of a wire frame, separate face and chin pads laced to the frame, and two adjustable head straps. The top head strap should be adjustable at the top of the mask, and the back head strap should be adjustable at both sides of the mask.

Dimensions. The overall length and width of the face mask may vary, but 10 inches long by 10 inches wide (including ear tabs) should be minimum for adequate safety. The mouth opening may be rectangular or diamond-shaped, approximately 4 inches in size. There are many variations in shape and design, but odd shapes which reduce the protection afforded by the mask should be rejected.

Design of face pads. The shock of an impact on the mask is absorbed by the forehead, cheeks and jaws, not by the temple. Pads should be suitably designed to afford maximum protection, resiliency and comfort, with packed stuffing evenly distributed. On top quality masks padding should be stuffed with washed, curled hair. Less expensive masks use white cotton or woolen waste. The leather for the pads should be full-grain sheepskin not less than 1/32 inch thick. This type of leather is used because of its softness, sponginess and pliability.

Head strap (top). The top strap should be made of leather, approximately 1¼ inches wide and from 14 to 15 inches long. One end should be sewed or riveted to an adjusting strap which is equipped with a center bar tongue buckle and which has at least four holes spaced ½ to ¾ inch apart for adjustment. The other end should be centered on the outside of the back head strap and securely stitched.

Head strap (back). The back strap should be elastic webbing, approximately 25 inches long and approximately 1¼ inches wide. The webbing should be reinforced at each end with leather. An adjustable strap as described in the above paragraph should be sewed or riveted to each end of the head strap.

Lacing tabs. The mask should be equipped with lacing tabs to secure the pads in position, or the pads may be laced to the frame in a continuous lacing. For either method the laces should be securely knotted to the frame, and the ends of the laces should extend at least ⅜ inch from the knots. This helps to prevent knots from loosening, and facilitates retying if needed.

Wire frame. The wire used in the fabrication of the frame should be not less than 16/100 inch in diameter, except the wire used to form the eye opening which should be not less than ¼ inch in diameter. Although difficult to ascertain without laboratory equip-

ment, it is recommended that pull to increase the distance between the top and bottom of the eye opening 1/4 inch be not less than 400 pounds.[11]

General items. The mask should be free from rough or sharp edges that might scratch or cut the wearer. All welding on the wire frame should be strong and reasonably free from pits and flashes. All rivets should be securely and neatly set and securely clinched. The wire frame should have a lusterless black finish to reduce reflection and prevent corrosion.

BAR MASK (ALLOY). With the exception of the frontal protective area, both the wire mask and the bar mask are constructed in much the same way. The padding, straps, lacings, and size are all similar.

One of the advantages claimed for the bar mask over the wire mask is the greater area of open vision. This may be an advantage or a disadvantage. For the young player changing from the wire to the bar mask there needs to be a psychological adjustment. After catching behind the bat with a wire mask the bar mask may give a feeling of insecurity. Actually under test conditions both masks, when of high quality, give more than adequate protection.

Sales literature often publicizes the lightness (sometimes as much as 30 per cent difference) of the bar mask over wire masks. Bar masks, in most instances, are lighter than *some* wire masks, but in selecting a mask, protection should be the first thought; the weight, second.

In both types of masks, it is the padding and straps that are least durable, and it is doubtful if the durability of wire versus alloy is an important factor in selection. However, the alloy bar is more durable than *poorly* welded wire masks for it is the welds that break first under a hard impact.

Of the 27 models studied it was found that there was little, if any, difference in cost between a bar mask and a wire mask of the same quality.

Sliding Pads

Pads, to protect the player against injury when sliding into base, are worn under the pants and fit over the hips. The professional pads similar to those worn by big league players are attached to a strong, durable waistband or joined with connecting bands of tape or elastic. Top quality pads have a double thickness throughout the padding and are quilted. A less expensive non-quilted pad is made with double thickness over the hips only. A plain weave, good commercial

[11] United States Office of Quartermaster General, *Mask, Baseball Catcher's*, May 15, 1945, pp. 3–4.

type cotton, of clean, well carded yarn shall be used. This cloth must be fully bleached, closely sized and desized before bleaching, and must not shrink more than 2 per cent when laundered.[12]

According to Quartermaster Corps specifications, pads shall be designed as follows:

> Pads . . . shall consist of 2 separate pads, joined at top edge and 2 of these joined with webbing, which shall form a unit. Pads shall be cut of print cloth, approximately 14 inches long and 12 inches wide, interlined with a cotton wadding, quilted and edges serged. Pads shall finish about 1/4 inch thick. A double ply of drill about 3 inches wide shall join 2 pads as a waistband and two such pads shall be joined by 2 strips of heavy webbing about 4 1/2 inches long as a back stay. A one (1) inch width webbing or tape shall be attached across the top of pads, extending about 17 inches on each side to serve as tie strings.[13]

Shirt

A wool flannel V-neck shirt with short sleeves, buttoned down the front, and trimmed with braid, is the traditional shirt style worn for baseball. Several professional ball clubs have adopted a uniform consisting of rayon shirts and shorts for play during warm weather. Numerals, letters or monograms are sewn on or woven into the shirt fabric. Medium quality shirts are wool reinforced with cotton, or a lighter weight wool flannel. Some less expensive shirts are made of cotton flannel. Figure 20 illustrates several styles in baseball shirts.

Styling features that contribute to comfort and action include ventilating eyelets under the armpit, raglan sleeves, an extra length in the body of the shirt. The Quartermaster Corps tentative specifications for baseball uniforms require that uniforms be of plain weave construction, 16 ounce flannel composed of 50 per cent cotton and 50 per cent wool. The wool must be chrome dyed and shrinkage shall not exceed 5 per cent. According to the specifications, the shirt shall be as follows:

> . . . a V-neck, coat style, free arm with half sleeves, either raglan or set-in. Shoulders, armholes, side seams and underarm seams shall be double lapped and double stitched seams. A two (2) inch facing of self material shall extend around neck and down each front about 18 inches from top of front neck line, with edges of facing trimmed with soutache braid. The bottom on fronts and backs and bottoms of sleeves shall be turned up

[12] United States Office of Quartermaster General, *Pads, Sliding, Baseball,* October 26, 1945, p. 3.
[13] *Ibid.,* p. 2.

Figure 20. Several styles of major league baseball shirts. (*Courtesy of Wilson Sporting Goods Company.*)

> and stitched. Bottoms of sleeves shall be trimmed with soutache braid. Underarm seams of sleeves and side seams of shirt shall be securely tacked at bottoms. The shirt shall have 6 buttons and buttonholes on fronts, equally spaced and 4 stitched eyelets for ventilation around arm pits. Size label shall be stitched at neck. Back of shirt shall have block numerals, 8 inches high. Numerals shall be of felt, consecutive from 1 through 15, in contrasting colors and stitched on . . .[14]

The shirt should conform to the minimum measurements listed in Table 4.

Shirt sizes, as labeled by the manufacturer, represent chest measurements, and are usually made up in sizes 32 to 44. Some concerns include size 46 in the regular stock shirt, but this size may be listed as extra large by other manufacturers and necessitate special order. Boys' uniforms are made up in sizes 6 to 14 years. Most shirts

[14] United States Office of Quartermaster General, *Uniform, Baseball,* September 28, 1945, p. 3.

Table 4

SIZE CHART FOR BASEBALL SHIRTS[15]

Size	*Back Length*	*Chest*	*Sleeve Length From Center of Back*	*Bottom Sleeve Opening Circumference*
40	32″	48″	20¼″	19″
42	32″	50″	20½″	19″
44	32″	52″	20¾″	19″
46	32″	54″	21″	19″

are solid colored and trimmed with braid of contrasting color or colors. Fabrics should have good color fastness to endure laundering, perspiration and weather.

Pants

Baseball pants are made from the same materials as the shirts. The two garments combined form the baseball uniform. Pants are similar to knickers in styling, mid-calf in length, with elastic often inserted at the bottom of the pants leg. A patch pocket is included on most pants, the crotch is ventilated in top quality pants, and inside tunnel belt loops are provided.

Quartermaster specifications require pants to be identical to shirts in weave, type and weight of material, and color properties, as follows:

> . . . full cut professional model with a cut through hip pocket on right back, and grown-on type waistband. Pockets, waistband lining and fly linings, shall be a good commercial grade of drill, sateen or twill. Pants shall have a conventional type of fly, 9 inch opening, with not less than 4 buttons and buttonholes with base of fly securely tacked and neatly finished without bulkiness. Pants shall be fitted with at least three (3) six (6) inch tunnel loops at waist and with one (1) inch loops on fronts to provide an opening for a two (2) inch belt. The inseams, seat seam and side seams shall be double lapped and double stitched seams. The bottoms of pants shall be hemmed with an inserted elastic not less than ⅝ inch wide. The bottoms of pants shall finish not less than eleven (11) inches in circumference when drawn in and the elastic shall permit the bottoms to be stretched

15 United States Office of Quartermaster General, *Uniform, Baseball,* September 28, 1945, p. 3. Also contains detailed specifications for buttons, braid and other shirt requirements.

to not less than 17 inches in circumference. There shall be four (4) stitched eyelets at bottom of crotch . . .[16]

Pants shall conform to the minimum measurements listed in Table 5. When ordering pants, whether from regular stock or custom-made, all measurements should be ascertained to insure that any unusual variation in measurement will be adequately met in the size ordered. Size of waist and seat are the most important measurements to secure if it is not possible to obtain all measurements. Uniforms are usually carried in stock in the following size combinations: shirts—32, 34, 36, 38, 40, 42, 44, 46; pants—28, 30, 32, 34, 36, 38, 40. Fast color, good quality thread and a minimum number of 8 stitches per inch are recommended in Quartermaster specifications for all uniforms.

Table 5

SIZE CHART FOR BASEBALL PANTS[17]

Size	*Waist Measure*	*Seat 9 inches from Top of Waist-band*	*Inseam*	*Outseam from Top of Waist-band*	*Front Rise from Top of Waist-band*	*Back Rise from Top of Waist-band*	*Knee*
32	34″	48″	25″	36½″	13¾″	19½″	21″
34	36″	50″	25″	36¾″	14″	19¾″	21½″
36	38″	52″	25″	37″	14¼″	20″	22″
38	40″	54″	25″	37¼″	14½″	20¼″	22½″

The official rules for men specify as follows:

> Every club shall adopt two uniforms for its players, one to be worn in games at home and the other in games abroad, and the suits of each of the uniforms of a team shall conform in color and style. No player who shall appear in a uniform not conforming to the suits of the other members of his team, shall be permitted to take part in a game. Glass buttons or polished metal must not be used on a uniform.[18]

Cap

Top quality caps are made of quality wool flannel, have a firm, stiffened visor that is lined with green ventilating eyelets in the

[16] *Ibid.*, p. 4.
[17] Ibid.
[18] *The Baseball Almanac*, 1949, p. 51.

crown, sweatbands (usually leather), and taped seams. Medium quality caps are made of cotton, or wool and cotton. The sweatband may be leatherette.

According to the Quartermaster specification, caps shall be 16 ounce wool flannel with chrome colors and shall show good fastness to laundering, perspiration and weather. Caps shall be as follows:

> . . . regulation type with a six (6) piece crown and a three (3) inch visor. All crown seams shall be faced with a 5/8 inch strip of tape or silesia and each section shall have a 1/4 inch stitched eyelet. The turn-up of crown shall be reinforced with a strip of buckram. The visor shall be made of three (3) pieces, of fibre interlining approximately 1/8 inch thick, and the bottom piece, green drill. A 3/4 inch sheepskin sweatband shall be attached to cap . . . A self cloth-covered button shall be securely riveted at the apex of the cap.[19]

Caps shall conform to the measurements listed in Table 6.

Table 6

SIZE CHART FOR BASEBALL CAPS[20]

Size	*Head Band Measure*
6⅞	21⅝″
7	22″
7⅛	22⅜″
7¼	22¾″
7⅜	23⅛″
7½	23½″

Hose .

Footless athletic hose are worn over socks. The hose extend well up under the pants (knee length) and fit securely on the leg with an elastic band at the top of the hose. Hose are either solid in color or are striped in contrasting colors. Socks are white, and white sanitary hose, both full and ankle length may be worn under the wool hose or socks by players who are allergic to wool. Best quality hose are medium weight, fine ribbed, and pure wool. The stirrup is usually a good quality cotton. Medium and minimum quality hose are constructed of coarser wool, rayon and wool, or cotton (heavy or lightweight).

19 United States Office of Quartermaster General, *Uniform, Baseball,* p. 4.
20 *Ibid.*

Quartermaster specifications for hose list the following requirements:

> Yarn for knitting the cuff top, body and anklet shall be a combination of worsted and cotton yarns. The worsted yarn shall be made from sound, strong staple fleece or pulled sheep's wool, not lower in grade than 50's U.S. Standard. The wool shall be carded, combed and spun into two ply on the worsted system. The cotton yarn shall be carded and combed, single or two ply, evenly spun from a suitable grade of staple in a knitted twist. The color of the cuff top and body portion of the stocking shall be commercially fast colors in solid Navy, Red, Green, Royal Blue or Black. The anklet portion shall be white.
>
> Yarn for knitting the stirrup shall be carded or combed, evenly spun from a suitable grade of staple cotton and twisted into a two-ply yarn, mercerized and finished natural (unbleached and undyed) . . .
>
> The finished stockings shall conform to the following measurements and weights:
>
> | | *Length (inches)* |
> |---|---|
> | Cuff Top | 3 |
> | Body (Half Cardigan) | 16 |
> | Ankle | 4 |
> | Stirrup | 4 |
> | Total Length | 27 |
> | Weight per dozen pairs (minimum) lbs. | 3¾ |
>
> The stockings shall be well matched and paired.[21]

Shoes

The cost and, to some extent, the durability of baseball shoes is in direct proportion to the type of leather used for the shoe upper and the type of construction used to unite the upper and the sole. The two processes used most often for baseball shoes are the Goodyear Welt and Littleway Stitch methods of construction. Figure 21 (a & b) illustrates two styles of baseball shoes (see page 52).

When selecting baseball shoes, the type of leather for the shoe depends somewhat on the budget. Because the fiber of the skin is interwoven instead of being in layers, shoes made of kangaroo are light, strong and quite durable. Weight for weight, kangaroo is the strongest of all shoe leathers. Whether it is blue-back or yellow-back kangaroo does not make too much difference. Medium priced shoes are usually made from selected calfskins or cowhides. These leathers

21 *Ibid.*, pp. 2–6.

are heavier than kangaroo, not as soft or pliable, but more scuff resistant. The least expensive shoes are made of horsehide, are relatively stiff, not as strong, but quite scuff resistant. Shoes made of horsehide are recommended for pre-high school ball players (see Leathers, pages 299–304).

Methods of tanning differ, but an oil-base tanning process used on cowhide often produces a leather that is more water resistant and scuff resistant than hides tanned by the ordinary processes. Shoes

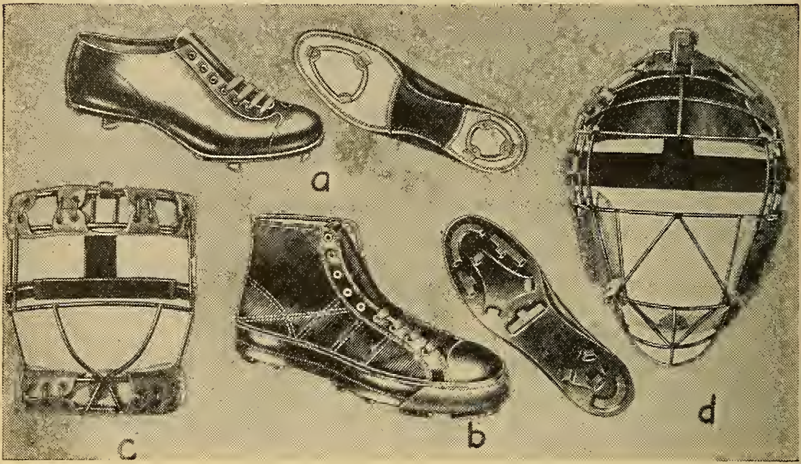

Figure 21. Shoes and masks: (a) regulation leather shoes with spikes; (b) canvas-top rubber-soled shoes, to be used when spikes are not allowed; (c and d) two types of wire frame catchers' masks for softball. (*Courtesy of A. G. Spalding and Bros., Inc.*)

made of cowhide uppers may be advertised as being made of athletic leather, Sportan or some other trade-name.

The shoe uppers and the soles are usually united in one of three ways. Two of them are unique: Goodyear Welt construction and Littleway Stitch. The Goodyear Welt process provides a shoe that is more durable, more comfortable (no stitching under the foot), and more expensive. The Littleway Stitch method combines sewing and the use of staples to unite the upper and the sole. Shoes made by this method are less expensive and less durable. A sure way to identify a Goodyear Welt shoe is to look under the insole. If thread or stitches show, it is not Goodyear Welt. Goodyear construction and Goodyear stitch are not similar, nor are they to be confused with Goodyear Welt (see Football, pages 135–137).

SOFTBALL

The development of the game of softball has been more or less interlocked with that of baseball and probably started as someone's desire for a variation of that game. The first game is reported to have taken place in a gymnasium when one of a group of men threw a boxing glove and another swung and hit it with a broom. One of the men offered to devise some rules and find equipment that would be more efficient. As a result, indoor baseball was originated in 1887 by George W. Hancock of the Chicago Farragut Boat Club of Chicago.

The game was immediately successful where indoor facilities were available. Soon it was necessary to find more space to accomodate those interested, and the game was moved outdoors. It then became known as playground ball.

In 1909 the National American Playground Association of the United States was formed. The rules adopted by that group were quite similar to present rules, except that the batter might run bases clockwise or counterclockwise, succeeding base runners necessarily following the pattern.

In 1927, the National Recreation Association drew up a set of rules for a modified game of baseball. Soon there were various sectional combinations, each with minor differences, such as size of diamond, circumference and weight of ball, type of cover on the ball and the weight and length of bat. By this time, the game had many names such as Kitten Ball, Softball, Twilight Ball, Playground Ball. At one period competition was held in the following types of games: slow and fast pitching—12, 13, 14, 16 and 17 inch balls; 30, 31½ and 35 foot pitching distances.

The Amateur Softball Association was organized soon after that and some attempt was made to standardize the rules. The Association claims that there are more than 5,000,000 active players in the game and sporting goods manufacturers acknowledge sales to be approximately $20,000,000 annually.

Equipment

Most of what has been written about the selection of baseball equipment is applicable to softball equipment.

Bat

Softball bats are somewhat smaller, with a maximum of 34 inches in length and maximum circumference of 2⅛ inches at the thickest

part. There is no limit to weight; but 31 to 34 ounces is average, depending upon length, style, and type of wood.

Gloves

Softball mitts and gloves are often used interchangeably with baseball mitts and gloves. The same care in checking and inspection is needed for both.

Bases, Body Protector and Mask

Quite often the same bases are used for both games. The chest protector (sometimes called body protector) is made of similar materials, but when worn by girls, should be slightly smaller and lighter. To prevent possible injury it is recommended that a body protection of molded fiber cups be worn by all girls catching behind the bat. Most softball masks are of the wire frame style and because of the greater size of the ball, have a more open construction. The wire need not be so heavy, but the same precautions as to welding should be followed. Padding, lacing and filler are similar. Baseball shoes are worn for both sports. When spiked shoes are not allowed, canvas- or leather-top rubber-soled shoes are suggested (see Figure 21).

Ball

The greatest difference between the equipment of both games is the size and construction of the ball. The Amateur Softball Association recognizes as official only the 12 inch leather-covered ball; however, many school, camp and playground programs have found advantages in using the 9, 10, and 12 inch rubber-covered ball and the 14 and 16 inch leather-covered ball. Leather-covered balls are also available in 9 and 10 inch sizes.

LEATHER COVERED. *Center.* The center should be of virgin kapok. Less expensive balls often have centers of reclaimed kapok. The least expensive balls have a center made of wool, cotton or some other resilient material. The kapok should be matted and compressed so as to produce substantially uniform weight. If paper wrapping is used in the processing of the kapok center, the paper should be kept at the outer surface and away from the interior of the kapok sphere.

Winding. At least two windings of yarn should be around the kapok center. The yarn should be suitably graduated in size so as to produce a smooth uniform surface after the last winding.

Cover. The cover should be securely cemented to the last winding and should be made of leather. Full-grained chrome-tanned cow-

hide is the best. Horsehide and kidskin are often used for less expensive balls. Horsehide is stiffer and more scuff resistant; but cowhide is softer, more pliable and finer grained. The two pieces of leather making up the cover should be sewed together at the edges.

Seams. There are at least four types of seams, each covered by a patent: Duro Seam, Clincher Seam, Concealed Stitch, and Protex Seam. Preference for one over the other is largely a matter of personal choice. Those players who favor the hidden-stitch type of seam agree that because there are no exposed threads, the durability is as much as four times as great. Those who are opposed to this type do so on the basis of feel and grip which is offered by the balls with a slightly raised seam.

Cover thickness. Because more cover body is needed to anchor the balls with concealed stitches, the covers should be slightly thicker than the open-seam type of ball.

Size. Leather-covered balls are manufactured in at least five sizes, 9, 10, 12, 14 and 16 inch circumference. Choice of size is dependent upon local rules, age and skill of players.

Finished ball. The cover should have no break in grain, loose fiber or deep cuts, nor should it be loose so that it creeps or bunches under finger pressure. There should be no broken stitches or torn needle holes caused by too much tension on the thread while sewing. No more than 1/32 inch should be between the meeting of the two sewn edges. For a 12 inch ball, the ball should be not less than 11.7 inches nor more than 12.1 inches in circumference; for the 16 inch ball, not less than 15.7 nor more than 16.3. For a 12 inch ball, the weight should be between 5¾ and 7 ounces; for 16 inch, between 9 and 11½ ounces. This size and weight deviation allows purchasing of seconds and top quality rejects to use as practice balls.[22]

RUBBER AND PLASTIC COVERED. Prior to World War II very few sporting goods manufacturers were making rubber-covered softballs in large quantities; now nearly all companies which produce the leather ball also offer a rubber-covered mold. Partially due to the scarcity of all athletic equipment and partially due to the fact that they were usable where leather-covered balls did not prove satisfactory, rubber-covered softballs gained more acceptance during and after the war. A more recent addition is the plastic-covered softball. This latter type, like the plastic-covered (sometimes called fabric-coated) football, is not yet available to the consumer.

[22] United States Office of Quartermaster General, *Ball, Softball (Leather Covered)*, June 28, 1945, pp. 3–4.

The Joint Rules Committee of the Amateur Softball Association does not recognize the rubber-covered ball as official. However, many schools, camps, and recreation programs have found it equal to or surpassing the leather-covered ball for durability. Especially is this true where play is on gravel, clay or macadam surfaces. Its waterproof cover is an asset on damp or wet fields.

The construction of rubber-covered and plastic-covered softballs is identical with that of leather-covered balls except for the cover. For the former, the cover should be a natural rubber, white and approximately .025 inch thick. It should be securely attached over the windings, molded with simulated seams and stitches to resemble the leather-covered ball, and then securely vulcanized to the windings. The plastic cover should also be white, approximately the same thickness, and securely bonded to the windings of the ball.

Uniforms

Softball uniforms for men are similar to baseball uniforms with the following differences: full length pants, as well as the knicker style, are worn by some teams; uniforms may be made of cotton, rayon, or wool reinforced with rayon; long-sleeved jerseys may be worn, in addition to the quarter length and raglan style. Figure 22 illustrates one type of softball uniform.

In informal games and physical education classes for girls, gymnasium costume is usually worn for softball. However, the official rules for women state:

> As a precaution against injuries and infection, it is recommended that players wear knickers, slacks or full length trousers.[23]

When the regular softball uniform is worn, the knickers are usually similar in styling to those worn by men, but have two side openings (button). Woven shirts or knitted jerseys, in any one of a number of styles, complete the costume. Caps and long wool hose are optional. Socks, instead of longer hose, are sometimes worn with the knickers.

CARE AND REPAIR

The repairing of baseball equipment is as important as for any other sport but usually not such a large task. Balls, mitts, and gloves need most of the attention. It is usually impossible to repair badly broken bats. Following are some suggestions for care and repair of several items of baseball equipment.

[23] *Official Softball-Track and Field Guide*, 1950, p. 59.

Figure 22. Softball uniform. (*Courtesy of Wilson Sporting Goods Company.*)

Balls

On leather-covered stitched balls, repair broken stitches immediately. Clean rubber-covered balls with a damp rag, or if oil and grease have accumulated, soap and water will not damage the cover. Do not use cleaning solvents since they may soften the rubber. Heat and direct sunlight for long periods of time may reduce the maximum durability of a rubber-covered ball. When not in use keep the balls inside.

Most of the repairs of balls consist of resewing torn threads. This should be done as soon as any stitch breakage occurs before the sewing has a chance to ravel out to any extent which would cause much additional work in resewing. Unravel a portion of the stitching at

each end of the break. Using two needles, pull the unraveled portion of the threads into the raw ball itself at each end of the break, as this will lock these threads and prevent further unraveling. Then use two threads and two needles tying a knot in the end of each thread. Push both needles, separately, through a portion of the raw ball, pulling the knot into the ball itself, then pass the needles through the raw ball a second time so that the threads are fastened securely. Then push the needles out through the holes where the first new stitch is to be started. Sew the opening using the two needles in the same manner as lacing a pair of shoes. When the last stitch has been completed, push the nedles through the seams into the inside of ball and out through seams. Trim threads closely.

Bats

No matter how fine a wood lathe job, most bats still have rough spots. Remove roughness by rubbing the bat with a bone. Many coaches and players treat their bats with a light coat of vegetable or mineral oil.

Unprotected wood absorbs and loses moisture rapidly with changing atmospheric conditions. As the moisture content changes, the dimensions also change, causing the formation of small cracks in the wood. When bats leave the factory they have a good varnish finish for protection against moisture changes, but this finish wears off during play. Refinish worn spots with a good grade of varnish.

Too often, young ball players have a habit of hitting pebbles and stones with a bat. This dents the wood, breaks the finish and breaks the outer grain, thus weakening the wood. Such a practice should be discouraged by coaches.

Gloves

The most common sources of trouble with baseball gloves are high temperature, excessive moisture and sand or grit. Green mold will rot leather. To prevent this keep gloves in a cool dry place. When wet from perspiration or precipitation, dry the gloves immediately but do not force the action. Drying at normal room temperature without the use of artificial heat is best. Repeated wetting and drying of gloves will cause the leather to become harsh and rough—perhaps it will crack. Application of a thin coat of vegetable or mineral oil at the first sign of dryness prevents such a condition.

Never throw gloves on the ground, especially if it is sandy or dusty. Sand and grit act as an abrasive on leather. Do not store gloves under other equipment. Weight tends to break down the molded pocket

and to shift the padding. Never use gloves for a seat or cushion. Repair broken stitching, even a single stitch, immediately. Wearing a glove made for the left hand on the right hand destroys the pocket and causes the padding to mat or move.

Clean gloves that have become soiled with saddle soap only. Apply the saddle soap with a moist cloth by rubbing the cloth over the soap to work up a cream on the cloth. Then rub soiled leather with the cloth until the dirt is loosened. Wipe off the dirty lather with a clean cloth. A brisk rubbing restores some of the gloss.

Repair a rip or tear occurring in the seam in the same manner as a rip in inflated goods. Remove the lacing and expose the ripped portion through the lace opening and sew as directed.

In the event of a cut or tear in the leather portion itself, cover it on the inside with a leather patch which is then hand-sewn about its perimeter; the sides of the cut or tear are kept together by hand stitching with the stitching passing through the bottom patch.

Shoes

See Care of Shoes, pages 264–267.

CHAPTER III

Basketball

Basketball is the newest of the major American sports. In 1891 Dr. James Naismith hung up the first baskets and developed the first rules at the Massachusetts YMCA School (now Springfield College). The game was strictly American during its early development, but now it is an international sport. Although designed as an indoor activity at the YMCA School, basketball is a popular outdoor sport in many countries throughout the world where the climate permits.

Equipment needed for the early game was rather simple—an inflated ball and two peach baskets. The uniforms consisted of knee-length padded pants or knee-length jersey tights with a quarter-length or sleeveless shirt. A soccer ball was used as the first basketball, but in about 1894 a larger ball measuring between 30 and 32 inches in circumference was adopted. The present ball is 29½ inches around. The weight of the first ball was between 18 and 20 ounces, but was found to be too light. The ball now weighs between 20 and 22 ounces. The backboards and baskets likewise have undergone considerable changes. Glass backboards were used as early as 1909, and early rules stated that unless the ball stayed in the basket a score did not count. Rubber suction-sole shoes were first used in 1903.

Equipment

Ball

Uniform
- jersey
- pants
- shoes

Ball

At least three types of basketballs are available on the market: molded, stitched and rubber-covered. At present the sewn leather ball is the official ball, but it has been announced officially that for the 1950–51 season the molded ball will be adopted.

According to some manufacturers who produce molded balls, such balls have proven, through laboratory and field tests, to outwear sewn balls by 200 to 300 per cent. Durability tests completed by the Office of the Quartermaster General, United States Army, show that in nearly 50 per cent of the cases tested (72 of 147) it was the stitching which broke before the lining, bladder or leather.

Table 7

TYPES OF FAILURES IN SEWN BASKETBALLS[1]

Name of Company	*Number of Balls Tested*	Type of Failure *Thread*	*Lining*	*Bladder*	*Leather*
A	2	1	1	0	0
B	21	8	7	3	3
C	30	20	4	2	4
D	6	1	4	1	0
E	6	3	3	0	0
F	27	13	2	5	7
G	7	2	2	2	1
H	43	21	18	2	2
I	5	3	2	0	0
Totals:	147	72	43	13	17

From the statistics in Table 7 indications are that if all failures of thread and lining could be eliminated, the durability of the ball would be extended. In similar tests of the molded ball these indications have been corroborated. The introduction of the molded ball has been the work of many, but special mention should be made of the National Federation of State High School Athletic Associations. According to the *Handbook* of the Federation:

> Much effort has been devoted to working out a cooperative arrangement with sporting goods manufacturers whereby top grade balls could be secured at a price within the budget range of a majority of the schools. In the course of their work, it became evident to members of the committee that the only satisfactory solution was the development of perfect shaped balls

[1] Engineering Division, Jeffersonville Quartermaster Depot, "Compilation of Data Pertaining to Types of Failures in Sewn Basketballs," August 9, 1946, p. 10.

through the use of molds or lasts. Acting on the theory that such method of construction was feasible, efforts were concentrated on the production of such balls. The invention of the molded type basketball was a direct result of these efforts. After such balls were produced it required a nationwide program to insure their acceptance. This was necessary because the balls had a slightly different reaction from the old sewed seam type. This reaction is just as satisfactory (in many ways more satisfactory) but required a transition period during which the success of the new product depended on the willingness of coaches, who had played in earlier years with the sewed ball, to modify their reactions. In general, fine cooperation along this line was secured. An experimental program was followed by tournament adoptions. The result is that a majority of all game basketballs are now made by the new method and as far as the high schools are concerned, the new product is considered greatly superior. The durability is at least three times as great and the shape of the balls is near perfection. Due to these activities, the number of players who find playing equipment available has been doubled and tripled and there is an actual proven saving to school athletic departments of at least one-half million dollars per year. Basketball courts are now put to maximum use and athletic departments are experiencing a new time economy.[2]

MOLDED. A molded basketball has no stitches, welts, laces or prominent seams, and is made on a form or last of controlled size and shape. Those companies which manufacture molded balls say the bladder is free from friction and chafe since it is an actual part of the ball. The last on which the ball is formed is made from wax. This at first is in a liquid state and is weighed and poured into one-half of a spherical mold. The mold halves are clamped together and then fastened into a machine which is rotated in two directions through a bath of cold water. This cooling action solidifies the wax into the hollow sphere, thus producing the last.

After the last is removed from the mold it is covered with several layers of light, strong fabric, and each section of fabric is fitted and cemented into place. The wax is then removed, and the rubber bladder is placed within the ball. Two self-sealing rubber valves are built into the bladder opposite each other to give balance. In addition, these two valves also give double protection against leaking, as a defective valve can be plugged, leaving the other usable.

At this stage of manufacture, with the bladder in place, the ball is known as the carcass. The carcass is then placed in a press mold

[2] *Handbook,* National Federation of State High School Athletic Associations, 1948 and 1949, p. 27.

and after the press is closed, the carcass is inflated with air and vulcanized. This process, in addition to curing the carcass into a homogeneous mass, molds ridges onto the surface of the ball which outline the shape of the leather panels. Panels are next cut out of leather into the conventional shape of a basketball. A coating of cement is applied to the panels and also to the outside of the carcass, after which the panels are carefully laid into the spaces between the ridges and butted against them. A groove in each ridge produces the same effect in handling the ball and in the flight of the ball as do the seams on a sewn basketball. These ridges or seams are known as channel seams. The carcass is then placed into another mold that vulcanizes the leather to the carcass, thus producing the finished ball.

When selecting a molded basketball, examine for:

1. Circumference—not less than 29 inches or more than 30 inches.
2. Weight—not less than 20 ounces or more than 22 ounces.
3. Rebound—a bounce of 49 to 55 inches when dropped from a height of 72 inches onto a solid wood floor.
4. Roundness—not be out-of-round by more than .25 inch.
5. Valve leakage—no leakage of air at either valve. Take all measurements when the ball is inflated to the pressure stamped on the ball.

Examine the leather panels for:

1. Type—cowhide, kip or calfskin.
2. Leather—no holes, cuts or deep scratches; no peeling or flaking of the pigment finish; pebble grained.
3. Color—same throughout.
4. Thickness—not less than 3/64 inch in thickness.
5. Correctness—no more than 1/32 inch between panels; no wrinkles or loose edges.
6. Alignment—molded ribs perfectly aligned with the joints between the panels.[3]

STITCHED. When selecting a stitched basketball, choice of the laced or the laceless model is a matter of personal opinion. Of the two types, the latter has the advantage of a completely smooth, round surface; the former is often longer lasting, since a broken bladder can be replaced easily in laced balls. All the criteria for selection of molded balls apply to sewn balls, but, in addition, it is important to check the stitching for such defects as needle chews, loose stitch tension, broken stitches, wrinkled seams and seams that have not been pounded out (flattened).

[3] United States Office of Quartermaster General, *Basketball, Molded*, June 5, 1945, pp. 2–3.

RUBBER COVERED. Rubber-covered basketballs are now in the same stage of development as was the molded basketball several years ago. Coaches, teachers, playground directors and players realize that such a ball has some outstanding qualities but that tradition and official rules deem it necessary to use a leather ball. Rubber-covered balls, like the molded leather balls, have a slightly different reaction and feel but many coaches and manufacturers believe that after a period of gradual transition rubber-covered balls will ultimately be sanctioned by most basketball organizations and rules committees.

It is necessary to make a differentiation between rubber-covered basketballs and rubber basketballs. The former are built along the same general pattern as leather balls; that is, each ball has a bladder, a fabric or wound cord carcass, and a cover. In this case the cover is made of vulcanized rubber. A rubber basketball usually has no bladder, no carcass or fabric foundation, and only a thin rubber cover.

Those players, coaches and industrialists who favor rubber-covered balls insist that rubber can be compounded in such a way, with many chemicals and ingredients, that a blindfolded expert cannot feel the difference between it and leather. Also they point out that on a leather basketball it is not the leather that a player feels but only a casein compound used for embossing the leather. Another similarity of the leather ball and the rubber-covered ball is their construction. Each is lined with fabric and is molded so that its various layers of bladder, fabric and cover form a cohesive unit, enabling the ball to retain its shape better than a stitched ball.

To construct a first quality rubber-covered basketball, a bladder is first machine-formed from natural rubber, processed to ensure maximum air retention, and then molded into a smooth surface to prevent chafing and friction caused by contact with an adjoining layer of fabric. From two to four layers of strong bias-cut fabric are then applied over it. For top quality rubber-covered balls the fabric laminations are treated with a rubber compound to increase strength and cohesion of the fabric. Rapid compression of air within the bladder gives the balls their rebounding action. After the covering is applied the ball is vulcanized in a heat mold. The temperature, though not hot enough to burn or weaken the rubber, is sufficient to vulcanize the three main elements of bladder, fabric and cover into a tough, cohesive unit.

A good quality rubber-covered ball is distinguished by the following characteristics:

1. Construction—a bladder (essential); natural rubber in the bladder provides the best air retention and service.

2. Fabric—excellent quality, close woven, finest long staple cotton that is specifically engineered and designed for each type ball.
3. Ply—strength and cohesion among the several layers of fabric.
4. Cover—high quality ingredients; some compounds of synthetic and natural rubbers are extremely tough, nonelastic and weather resistant. Cover will not scuff, peel, split or crack and is not spongy.
5. Adherence to official standards—official rules specify the use of leather balls, but officialdom has, in recent years, sanctioned the use of rubber-covered balls under certain conditions.

Uniform

Basketball is fast-moving and packed with continual, vigorous action. It is a sport that calls for a wider range in arm movement, especially in overhead extension, than most other sports. In spite of rules to the contrary, there is a certain amount of body contact in the men's game.

These factors necessitate an emphasis on three items in the check-list of clothing properties—safety, coolness, and elasticity, especially in shirts for overhead arm action. With the exception of the items listed here, basketball costume is the same as that worn for gymnasium activities (see Gymnasium Costume, pages 288–296). Some commercial or professional women's teams wear a costume similar to that worn by the men, but most women wear regular gymnasium costume. Figure 23 illustrates a typical basketball uniform for men.

PANTS (shorts). Basketball pants differ from regular gymnasium shorts in three ways: (1) they may be provided with hip pads; (2) they may have knitted inserts at the side and/or bottom of the pant leg; (3) they have separate or attached self belts.

Hip pads are an added safety provision. They may be sewn into the pants or worn separately. Knitted inserts permit vigorous and wide range of leg movement and add to a neat, trim appearance. Belts, in addition to providing for a better fit at the waistline, also serve to hold the pants in place. Some pants have a nonslip waistband. Plain, twill and satin types of weaves are used. For everyday wear cotton is the standard fiber used in most shorts. The high luster of rayon has spectator appeal, and this fiber is used in suits that are worn mostly for formal competition. Some schools use rayon exclusively. The majority of shorts are made in solid colors with contrasting colored inserts or trim.

JERSEY (shirt). Sleeveless style shirts are worn much more frequently than those with the quarter sleeve. Styling variations and

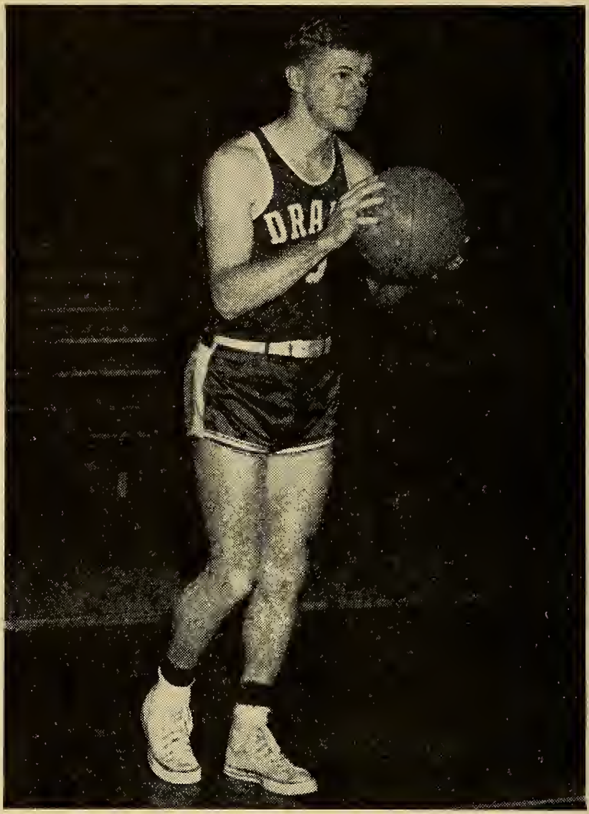

Figure 23. Basketball uniform. (*Courtesy of News Bureau, Drake University.*)

characteristics are similar to those used for gymnasium suits. Supporter attachments may be used on basketball shirts. Wool, because of its excellent moisture absorbent property, is popular for basketball shirts. Wool-rayon combinations provide moisture absorbency, luster and strength. Cotton or cotton-rayon combinations are suitable for warm weather.

Basketball shirts are manufactured in solid colors. Variations in design are achieved by using solids and stripes, solids and colored inserts, or solids and contrasting color trim at neckline and sleeves. Shirts may match or contrast with the color of the shorts. In extramural competition the home team wears white.

SHOES. The most important piece of personal equipment for basketball is the players' shoes. Whether the uppers are made of canvas or leather is a matter of personal choice. Leather-top shoes are more expensive, need more care during the season, but usually wear longer and usually present a better appearance. Kangaroo basketball shoes are the lightest of the leather shoes; cowhide uppers are perhaps more durable due to increased thickness.

Canvas-top shoes are less expensive than leather and can easily be washed in a shower or with mild soap and lukewarm water. The top should be high enough to protect the ankles; the soles should be examined for potential ability to absorb shock and should have good abrasive-resisting qualities and good adhesion to a wood floor. Shoes with a shank fitting, usually a rubber bottom, provide support for the arch and comfort to the wearer. A webbing-reinforced upper is better than one not reinforced. The outsole should not be less than 3/16 inch thick. (See Figure 23).

When selecting basketball shoes, examine them as follows:

1. Counter—for omission, uneven placement or wrinkles which might cause discomfort to the wearer.
2. Uppers—for cuts, holes or tears in the fabric; deep scratches or scars on the leather.
3. Eyelets—for poor clinching or looseness.
4. Gum parts—(toe cap, foxings, and outsole adhesion) for any separation between gum parts or gum parts and fabric; raised blisters.
5. Shoe for height—approximately 5 inches from insole to top of the upper (for size 9).
6. Shoe for weight—not less than one pound 8 ounces or more than 2 pounds 4 ounces per pair (size 9).
7. Insoles—for wrinkled condition that might cause discomfort; insoles should not be short, and should have good adhesion.
8. Stitching—for loose tension resulting in loosely secured seam or stitch, broken stitches; and type of stitching. Goodyear stitching is preferred.[4]

Care And Repair

For material on care and repair of basketballs, see pages 268–270; for shoes, see pages 264–267.

[4] United States Office of Quartermaster General, *Shoes, Athletic,* November 22, 1946, pp. 3–7.

CHAPTER IV

Bowling

As with many other sports, the origin of bowling is lost in the past, but there is sufficient evidence to date bowling in England back to the thirteenth century. Bowling was made a forbidden activity by the English Parliament and several of the kings because of its interference with archery. Additional discredit was given to the game when it became associated with gambling and taverns.

Toward the end of the sixteenth century bowling again was permitted for certain classes, and many of the English nobility became skilled bowlers. However, from 1541 to 1845 the common people of England were forbidden to bowl at any time except during the Christmas period and then only in their master's house and presence. By the early seventeenth century the Dutch had introduced the game into what is now New York, and Bowling Green is still a landmark of that city. When the game was moved indoors floors were constructed of baked clay, then of slate blocks, and finally of wood.

Bowling balls also underwent a decided change. The first ball known was made of stone, one-half spherical and the other half egg-shaped. The varied density and shape of the two halves caused the ball to curve. Lignum vitae, a very hard, dense wood, was next used, but still in the unique half oval, half oblong shape.

The official ban was placed on the game of nine pins in the early nineteenth century at the urging of a reform group, but another pin was added and the game legally continued as ten pins. Following the

Civil War bowling clubs were organized in many localities, but the various clubs played various rules. In 1895 the American Bowling Congress was formed, and through it bowling became an organized game played under an organized set of rules. Perfectly round, balanced composition-rubber balls are now the official balls.

Duck pins, a form of bowling involving the use of small pins and small balls, is probably an offspring of lawn bowling, as evidenced by the fact that the balls are almost identical in size. The National Duck Pin Bowling Congress was organized in 1927, and since then the game has had its greatest success in the eastern states and to some extent in the south. Nearly all individual or team records are held by duck pin bowlers from these areas. Alleys for duck pins are the same size as those for regular bowling, but the balls and pins are scaled down in size.

Bowling has continued to grow and is now the leading participant competitive sport. Twenty million men and women bowled in 1948.

Equipment

Ball	Shoes
Ball carrier	Costume

Ball

To be official, a ball must have a diameter of 9 inches, a circumference of 27 inches, and weigh not more than 16 nor less than 10 pounds (see Figure 24). There are two general types of balls, the solid black and the more highly polished mottled ball. Both balls are made of composition rubber, but the mottled ball is slightly harder and is colored with various dyes and pigments, brown being the most common color. Bowling experts have said that the added pigments have no effect on the ball, but because no two balls are exactly alike in design and appearance mottled balls are easier for bowlers to identify when balls are lined up on ball racks. Identification of the solid black balls is possible through the use of initials or numbers.

The terms mineralite and ebonite are often referred to when discussing bowling balls. Both terms are trade names used by two of the largest manufacturers of bowling balls. As far as can be ascertained, both mineralite and ebonite balls are made of substantially the same materials. Both companies produce mottled balls as well as solid color balls.

The solid black ball, because it does not have a high polish, is preferred by the bowlers who curve or hook their balls. The mot-

tled ball, because it is so highly polished, does not curve easily and consequently is preferred by the straight-ball bowlers. Most experts use a solid black ball, 16 pounds in weight. Many women use a ball weighing 12 to 14 pounds, and bowlers ten to fourteen years of age should use a ball weighing 9 to 10 pounds. For beginners or occasional bowlers, the three-hole ball is the most popular. Most experts use a two-hole ball. While every bowling alley furnishes balls,

Figure 24. Bowling ball. (*Courtesy of The Brunswick-Balke-Collender Company.*)

if a person plans to bowl often or in league competition, it is best to have a ball that is made to the individual's hand size and grip. Reputable sporting goods dealers will aid in measuring and proper fitting.

A ball should be selected with the finger holes spaced so that the ball can be held easily and naturally. If stretching is needed to reach the holes, or if the hand feels pressed and cramped, the ball is not the correct size. When the holes are properly spaced, there should be room to slip a lead pencil between the ball and that portion of the hand between the thumb and index finger. Holes that are too large do not permit good control, and holes that are too small require undue speed to release the ball. Care should also be taken to

determine the pitch of the holes that is best suited for one's hand. Bad pitch, wrong spacing and tight finger holes not only cause the ball to cling to the hand, but also tend to produce blisters and sprained hands. Holes that are too tight produce blisters on the joint of the thumb, while those that are too loose produce blisters on the base of the thumb and the inside of the middle finger.

The balls used for duck pins are made from the same hard compo-

Figure 25. Duck pin balls. (*Courtesy of the Brunswick-Balke-Collender Company.*)

sition rubber as are bowling balls. The maximum weight is 3 pounds, 12 ounces, and the diameter cannot legally exceed 5 inches. There is no minimum weight. Duck pin balls do not have holes bored in them for throwing (see Figure 25).

Ball Carrier

For bowlers who have their own balls, a ball carrier is essential. Carriers are made of many fabrics and leathers including canvas, cowhide, kipskin, elkskin and genuine elk. A bowling ball, when properly cared for, will last many years, usually the bowling life-

time of any one person. Ball carriers when given the same care will last equally well. When appearance is an important factor, the more expensive leather carriers are suggested.

Any ball carrier should have the following characteristics: (1) easy accessibility, that is, ample room for removing and replacing the ball; (2) a concave base or stand inside the carrier so that the ball will not roll, thus bursting the carrier seams, while being carried; (3) a frame, made of wire or some other material, to give the carrier the desired shape; (4) a securely fastened handle that will withstand the strain of carrying a 16 pound ball. The more expensive carriers also include a separate section for carrying bowling shoes.

Except for size, all the points suggested under regular bowling ball carriers might be followed for duck pin bowling.

Pins

Of no concern to the individual bowler, but a constant problem to bowling alley managers and owners is the matter of pins. The American Bowling Congress specifies that pins sanctioned for league and tournament competition must be made of clear, hard, solid maple (see Figure 26). This automatically disqualifies laminated maple pins and pins made of plastic, both of which have several advantages. In a test still being conducted by a large bowling establishment in the midwest plastic pins are three and one-half to four times as durable as regulation maple pins. In addition, the initial cost of plastic pins is lower. As for laminated pins, it has been suggested that they are less apt to snap off at the neck when compared to the breakage rate of solid maple pins.

Since no bowling pins that have been trimmed, refinished or had the bottoms turned down may be used for league or tournament play, most bowling alley managers use the reconditioned pins for morning and afternoon non-league play. Usually a bowling alley manager will put new pins on the alley twice during the year, in October or November and again in January.

Duck pins for league and tournament play must be made of solid maple, 9 13/32 inches high and between 4⅛ and 4 3/16 inches in diameter. A rubber band encircles the pin used in rubber band duck pin bowling (see Figure 27).

Costume

With the exception of shoes, apparel worn for bowling includes any items of general sportswear that are comfortable and in good taste. Women usually wear sport dresses or slacks; men wear comfortable slacks or trousers, and sport shirts. The main consideration

Figure 26. Bowling pin. (*Courtesy of The Brunswick-Balke-Collender Company.*)

in selecting clothing for bowling is to be sure that there is sufficient freedom of arm movement and ample allowance for a long stride (see General Sportswear, pages 278–288).

Street shoes with leather soles are sometimes too stiff to grip the floor well; sneakers and rubber-soled shoes allow too little or no sliding. Bowling shoes with a tip or half-sole made of leather should be worn. Since the bowler slides on the foot opposite the hand with which he delivers the ball, a right-handed bowler should have a leather half-sole (elkskin preferred) on his left shoe and the left-handed bowler should have one on his right. The shoe should be fitted carefully. If the shoe is too large, the foot will slide in the shoe and a blister may form. Rubber heels for bowling shoes are suggested since they will act as a brake and prevent too much sliding on a slippery approach to the alley. Most bowling alleys require the use of regulation shoes and when such is the case, provision is made for the rental of shoes at the alley.

Care And Repair

Bowling equipment, although not exposed to the out-of-doors atmospheric conditions, still needs to be given reasonable care if maximum performance and usefulness are to be achieved.

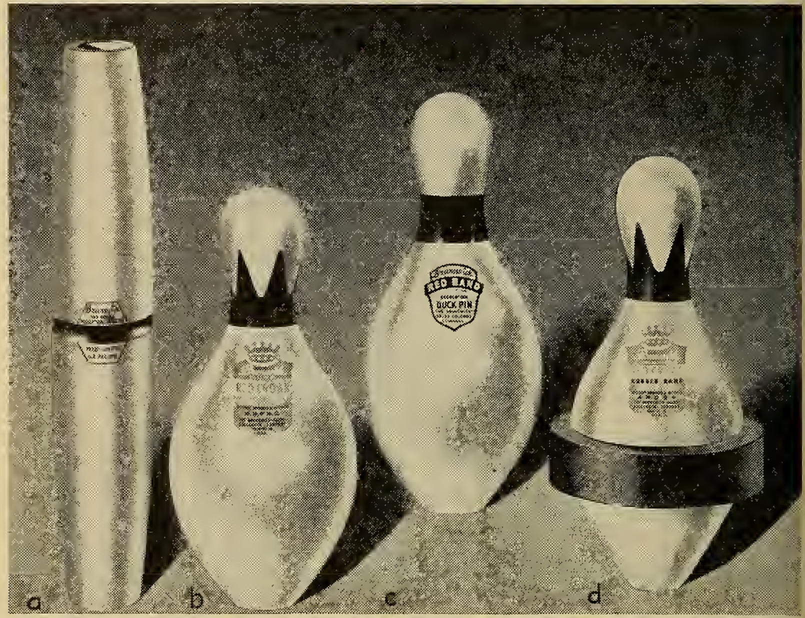

Figure 27. Candle and duck pins: (a) candlepin, (b and c) duck pins, (d) rubber band duck pin. (*Courtesy of the Brunswick-Balke-Collender Company.*)

Ball

Occasionally a newly purchased ball will crack or chip around the finger holes. This is often caused by improper boring and most sporting goods dealers will repair or replace the ball. Do not drop a ball on concrete, cement or any other hard surface while carrying it to or from a bowling alley. Such a drop will often cause the ball to chip. Use soap and water to clean the ball quite frequently. If several layers of bowling alley wax should collect, a special bowling ball liquid cleaner may be needed.

Pins

During the off season, place bowling pins in special wooden boxes, preferably those in which they were shipped, and store the boxes in a dry place.

During the season, remove from play immediately pins that are cracked or broken. Turn down on a lathe and refinish pins that get

round bottoms from hard usage, but be careful that in the process of reconditioning, there is no violation of size, weight specifications and tolerances as prescribed for official equipment. Clean both plastic and wood pins as often as is necessary.

Carrier

Quite often the metal or slide fastener is the most fragile part of a bowling ball carrier. If the carrier has a wire or metallic frame, do not allow it to become crushed by placing it on a seat or on the floor where it might be trampled. Repair immediately any stitch, tear or break, and watch the handle for loose rivets or threads.

Shoes

Give bowling shoes the same care as street shoes, mainly polish and new insoles and half-soles when needed. Do not wear bowling shoes on the street at any time, and even when indoors it is best to wear them only while bowling.

CHAPTER V

Boxing and Wrestling

BOXING

The peoples of the ancient world universally recognized boxing as an excellent method of training for hand-to-hand combat, but it remained for the Greeks to elevate the activity to the status of a sport where brute strength was secondary to form, skill, and technique. As a sport, the hands were protected by the caestus, strips of soft leather wrapped around the knuckles and held tightly in the clenched fist.

With the degeneration of Greek athletics boxing ceased to be a sport. Among the Romans, its practice was confined to gladiatorial professionals who, often with a captive girl as their prize, risked mutilation or death in savage, bloody combat. The caestus, originally a protective device, now became an instrument of mayhem and murder. It was increased in weight and often two or more sharp barbs were attached. These changes in the caestus necessitated improved fighting technique. With most of the added weight strapped to the palm of the hand, a chopping blow was used on the head and neck and a powerful round-house swing dented the ribs and upper extremities of the body. The objective of boxing was to maim or kill the opponent.

When Rome fell, formal exhibitions of pugilism disappeared, but violent personal combat, catch-as-catch-can, rough-and-tumble wrestling with no holds barred persisted throughout Medieval Europe.

With the further degeneration of the sport the caestus also disappeared, but biting, gouging, kicking and butting replaced it in the art of self-defense.

It was not until the eighteenth century that boxing regained recognition as a sport. Fighting with the fists had long been a part of the regular training of swordsmen, and as life became less violent and recourse to swordplay less frequent, fencing masters and professional swordsmen turned to the development of boxing as their secondary accomplishment. Boxing rapidly replaced sword-fighting as a public attraction. One of the first professional promotions was an international match between an English boxer and a Venetian pugilist in 1733. Knuckles were bare, wrestling holds were permitted and the objective was a knockout. In 1743 Jack Broughton, an Englishman, drew up the first formal rules for pugilists and also invented a boxing glove called a muffler. It was similar to a present day mitten worn during the winter, but it was used only in practice and training. Its avowed purpose was to prevent persons of quality from receiving black eyes, broken jaws and bloody noses. Boxing later became a part of the education of nobility and peasants alike.

A refinement of the rules in 1866 added prestige to the sport. For the first time gloves were compulsory and spiked shoes were banned. The transition from boxing with bare knuckles to boxing with gloved protection had been slow, but gloves provided the needed protection for hands.

Boxing long has been a public sport, and today is is one of the most controversial sports, although it is practiced in many colleges. In a sport where safety is involved the best possible equipment should be provided.

Equipment

- Gloves
- Training bag
- Striking bag
- Striking gloves
- Protection cup
- Head protector
- Mouthpiece
- Uniform
  - pants (trunks)
  - shirt
  - shoes

Gloves

Boxing gloves are designed with the thumb free, with the thumb sewed to the palm, and with no thumb. The Official Rules Committee of the National Collegiate Athletic Association recommends the latter two types of gloves for the reduction of thumb injuries. Special

gloves should be used for training with the light or heavy bag. Figure 28 illustrates one style of glove.

Gloves with an elastic band are better than those with laces; they are easier to put on and remove and there are no loose laces to cause eye injuries. Where laced gloves are used, the ends of the lace should be held in the contestant's palm inside the glove. Remove metal lace tips. Knots on the ends of the laces will prevent pulling through the lace holes.

Twelve ounce gloves are suggested for contestants up through the

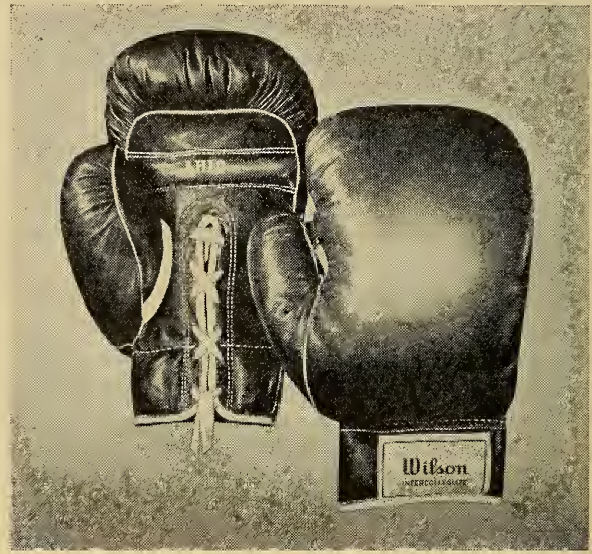

Figure 28. Boxing gloves (match). (*Courtesy of Wilson Sporting Goods Company.*)

132 pound class and 14 ounces for all above that class. For college, no glove should weigh less than 12 ounces. In competition professional boxers use gloves that weigh 6 or 8 ounces. Where the budget will allow two kinds of gloves, heavy 14 or 16 ounce gloves are recommended for training purposes.

The leather for the face (covering starting at topmost seams of the glove front and extending up over the fingers and down the back to bottom edge of the glove) normally is red and should be lambskin or sheepskin. The collagen or leather-forming fibers of lambskin and sheepskin are extremely thin and not closely interwoven, and the fibers tend to run parallel to the skin surface, causing a loose and spongy texture essential to boxing gloves but undesirable in other

types of athletic equipment. There should be no holes, cuts or deep scratches on the leather. Often, medium priced gloves may be made of leather with healed-over scars and insect bites. These defects may affect appearance, but usually will not lessen serviceability.

There should be no needle cuts or chews, broken or skipped stitches, or splits in the gloves. The padding should be of curled cattle or goat hair, free of lumps, and inserted so as to prevent shifting or packing under rough usage.

Boxing gloves should conform to the measurements in Table 8. Although gloves may vary in weight and measurements, each glove in any pair must be matched with the other.

Table 8

SIZE CHART FOR BOXING GLOVES[1]

	8 oz.	*10 oz.*	*12 oz.*	*14 oz.*	*16 oz.*
Weight (ounces)	7½–8½	9½–10½	11¼–12¾	13¼–14¾	15½–16¾
Length around the face, approximate	15½″	17½″	19″	20″	20¼″
Length of palm, approximate	9″	9¾″	10″	11″	12″
Length of palm grip, approximate	5″	5¼″	5–6″	5–6″	6″
Width of palm, approximate	⅝″	⅝″	⅝″	⅝″	⅝″
Width of cuff	2–3″	2–3″	2–3″	3–4″	4″

Training Bag

The primary purpose of the heavy training bag is to strengthen the hands and wrists and to develop striking power. There are many sizes and weights of training bags, and all serve this primary purpose. The standard bag is 36 inches high and 14 inches in diameter. However, it may be 36 by 12 inches; 40 by 24 inches; 44 by 22 inches; and 60 by 14 inches.

The important feature of the training bag is the stuffing. It should be clean, soft-textured cotton waste, or washed and degreased soft hair. Less expensive bags may be stuffed with wool waste that is not so resilient. Stuffing that is not firmly packed may shift because of an impact; it is important that stuffing stay in place under a hard and repeated blow.

[1] United States Office of Quartermaster General, *Gloves, Boxing,* February 24, 1945, p. 2.

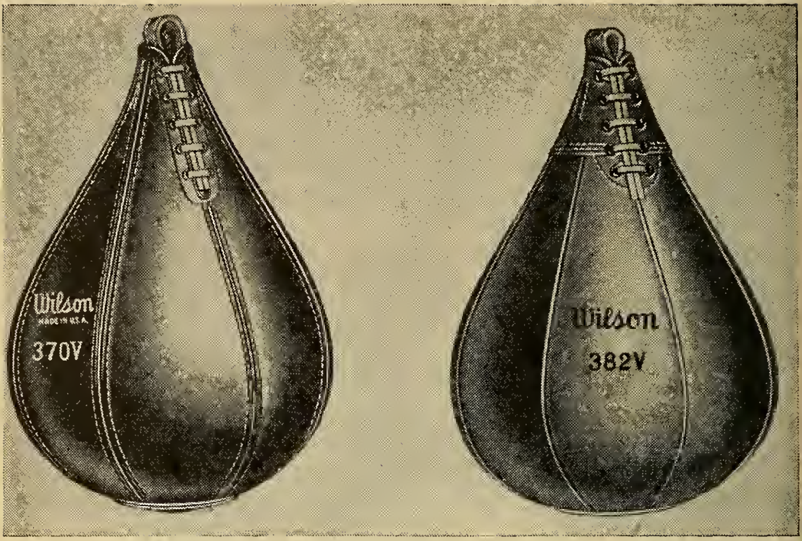

Figure 29. Two types of striking bag. (*Courtesy of Wilson Sporting Goods Company.*)

Most training bags are made of duck or canvas but many professional boxers and some gymnasia prefer bags made of cowhide leather. Both should be filled with a suitable stuffing as described above. The suspension device may be rope, chain or webbing, but chains usually provide the most security. If a long suspension chain is used, a short snub chain should be attached to prevent a free swinging bag.

The sewing or stitching of the suspension device to the training bag is important, and should be checked carefully. Broken stitches and loose stitch tension are starting places for rips and tears. There should be at least three rows of stitching to hold the suspension device to the training bag.[2]

A training bag can be made inexpensively by using a duffle or sea bag filled with cotton or wool waste, sawdust, or a combination of the two.

Striking Bag

This type of equipment is frequently referred to as a light bag or heavy bag, and, according to some boxing instructors, will develop

[2] United States Office of Quartermaster General, *Bags, Training, Boxing,* June 1, 1945, p. 2.

speed and striking coordination (see Figure 29). The speed of the bag varies according to the kind of leather and the type of lining used. For example, kangaroo leather, because of its lighter weight, is normally used when speed is the primary requisite. Cowhide is considered to be more durable. Striking bags advertised as being made of elk leather are in reality manufactured from cowhide or kipskin shoe leather. Such advertising should be qualified as elk-finished cowhide or elk-finished kipskin.[3]

Unless the budget permits both bags, a choice must be made between the heavy (20 to 24 ounces) bag or the light (15 to 16 ounces) bag.

LEATHER. The leather for the cover and disk reinforcement should be full-grain steerhide, cowhide or pigskin (inferior to the first two) for Type 1; kangaroo or kidskin (goatskin and kidskin are used interchangeably) for Type 2. The bags may contain either 6 or 8 panels, but panels should be free of deep cuts, sponginess or loose fibers. The thickness of the leather for Type 1 is approximately twice that for Type 2.

FINISH. The finish should not peel, crack, or flake when the leather is bent upon itself.

LINING AND SEWING. Type 1 should have a laminated fabric lining of at least two plies; Type 2 may be single ply. The warp or filler direction should be parallel to the long axis of the ball. The disk reinforcement should be sewed with a double row of stitching, 5 to 8 stitches per inch with six-ply or better linen thread. Lock-stitching is preferred to chain-stitching. The seams uniting the panels should be leather welted, and sewn with linen thread, 5 to 7 stitches per inch. The bladder should be securely cemented to the lining of the bag at the valve opening.

HANGER. The hanger should be $\frac{3}{4}$ to 1 inch wide and should project approximately $1\frac{1}{2}$ inches above the top of the bag. The hanger should be fabricated from not less than three plies of leather, and should be securely sewed or sewed and riveted to the inside of the bag at the top.[4]

[3] Tanner's Council of America, Inc., *Dictionary of Leather Terminology*, 1946, p. 13.

[4] United States Office of Quartermaster General, *Bag, Striking*, December 20, 1944, pp. 2–4.

Striking Bag Gloves

The type of leather used determines to a large extent the cost and to some extent the durability of striking bag gloves. Kidskin, cowhide and sheepskin leathers are used most often and are priced in that order, high to low. Whether or not the palm grip is weighted is a matter of personal choice. There should be an elastic binding on the inside of the wrist. Gloves padded with hair are less apt to mat, and perspiration has less effect on these than on kapok or felt (see Figure 30).

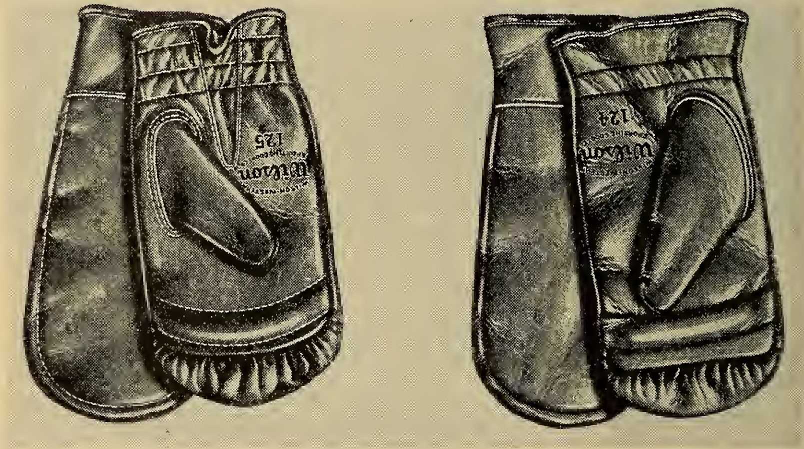

Figure 30. Boxing gloves (striking bag). (*Courtesy of Wilson Sporting Goods Company.*)

Protection Cup

All boxers must wear a protection cup. The foul-proof cup is one which protects the groin as well as the reproductive organs. In some states it is required to be worn by law. The cup should be made of bakelite or aluminum and should be worn with a pouch supporter. If a pouch supporter is not used, the cup should be slipped in between two regular supporters and then taped to prevent slipping or shifting.

Head Protector

There are many different types of boxing helmets, some protecting the ears, eyes and temples, (see Figure 31), others completely covering the jaw and face. Foam rubber padding is more resilient than kapok, and should be used over the forehead. Kapok is suitable for

ear protection. If a full-face mask is worn, the mask should have an outer wall of molded fiber board. The head protector should be adjustable to the wearer's size and shape of head. Correct fit is essential.

Mouthpiece

Mouthpieces should be nontoxic, nonirritating and free of any unpleasant-tasting substance. They should be worn on the upper

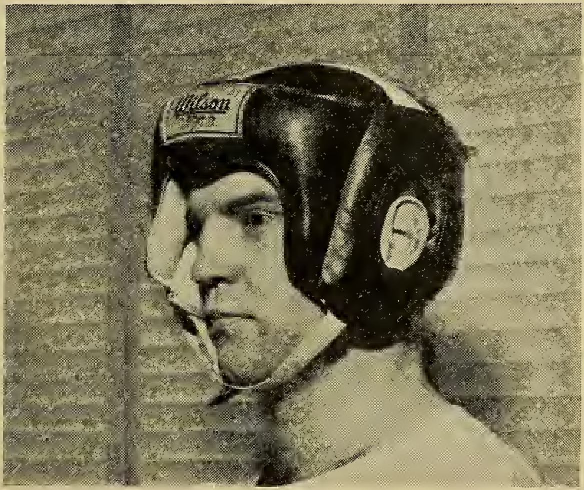

Figure 31. Protective headgear for boxers. (*Courtesy of Wilson Sporting Goods Company.*)

teeth and designed to minimize the effect of blows and to reduce cutting of the lips. The weights of mouthpieces differ, but on the average, they should be not less than 9 nor more than 13 grams. The minimum thickness of the rubber section between the teeth should be 1/8 inch.

Each contestant should have his own mouthpiece. Wash it in hot but not boiling water before and after each usage.

Uniform

Boxing has long been a sport promoted as a public exhibition. It is logical then that the costume leans towards the showy side. Since the objective is body contact, the upper part of the body is left bare in professional boxing. With the exception of the items listed here, boxing costume is the same as that worn for gymnasium activities (see Gymnasium Costume, pages 288–298).

PANTS. Unlike gymnasium shorts, boxing pants are cut straight across at the bottom of the pants leg. Crotch seams are reinforced for extra strength. Waistbands are wider than those used on other shorts styles in order to provide additional support in an area that is particularly vulnerable to body blows. Pants have elastic waistbands without openings at any part of the waistline. The name "boxer" has been coined to describe shorts or swim trunks of similar style. Contrasting colored striping is used as a trim at the sides of the pants. If basketball or gymnasium trunks are worn for boxing, metal buckles must be covered with adhesive tape.

SHIRT. In school and college boxing matches sleeveless shirts are required. The official rules for men specify that

> Contestants must wear sleeveless jerseys and trunks. The name of the college or school shall appear on the front of the jersey. Trunks to be legal must have a three (3) inch minimum inseam and a sixteen (16) inch minimum outseam and should fit rather snugly about the legs.[5]

SHOES. Because of budgetary restrictions, in many instances the regular type of basketball shoe is worn for physical education class instruction in boxing and for intramural boxing competition. When training is done on a wooden floor, regular basketball shoes should be worn. For varsity competition, light, fitted, soft-soled, high-laced shoes should be used when boxing on canvas. Kidskin or calfskin leathers, because of their softness and pliability, are used in the top grade shoes. A leather sole is essential. When selecting shoes, check the stitching of the uppers to the sole; the clinching of the eyelets; the stitching and secureness of the tongue. The finish of the leather should not peel, crack or chip off when the upper is bent upon itself; neither should there be any deep cuts, scratches or scars.

Care And Repair

Wash *gloves* with saddle soap once a week (if used daily) and allow to dry thoroughly. After drying, apply a solution of 10 per cent carbolic acid and 90 per cent sweet oil to disinfect and at the same time soften the leather. Repair immediately tears and rips. Discard gloves that are badly scuffed or cut, or use them for bag work. Gloves with padding that is matted, bunched or broken can be reconditioned by an athletic equipment renovator. Store gloves in open wire racks. Do not use gloves for pillows or throw them on the floor.

[5] "Official Boxing Rules," *Official NCAA Boxing Guide,* 1950, p. 79.

Examine all harness and straps for broken stitching on *helmets* and *bags*. Always wash and thoroughly dry helmet padding. Inspect the striking bag platform for loose bolts or damaged swivels. A ball-type swivel is recommended.

WRESTLING

Wrestling, like boxing, was a favorite exercise of all the earlier warrior nations. Most of the grips and falls used by modern wrestlers are portrayed in 3000 year old paintings which decorate the walls of the tombs of an Egyptian, Beni-Hassan.

In the Grecian era, wrestling received its first major impetus as a sport. The styles and techniques developed in the palaestrae and in early Olympic competition have undergone few basic changes. They appear today as the two most widely used forms of wrestling—Greco-Roman, or upright wrestling in which holds below the waist are not allowed; and prone wrestling, the type familiar to American sport enthusiasts.

Emphasis on wrestling as a means of military training, rather than as a pure sport, returned with the ascendancy of Rome. For centuries thereafter wrestling was practiced as a part of hand-to-hand combat. During the seventeenth and eighteenth centuries many new and widely varied styles evolved, but none achieved widespread popularity. Holds were often restricted to some article of clothing, and even today, in Schwinger, traditional sport of the Swiss, holds are still limited to a special belt and trousers.

In the past two decades professional wrestling in the United States has undergone a marked decline, and has the reputation of being a very profitable but unwholesome racket. Amateur participation has increased appreciably, especially in high schools and colleges.

Equipment

Mat	Uniform
Mat cover	pants
Helmet	shirt
Protective supporter	shoes

Wrestling requires less equipment than almost any other sport. Mats or some type of soft surface are a necessity, and in many schools, regular gymnasium mats are used for the sport.

Mats

Any soft, resilient material can be used for mats, ranging from the best hair-felt mats, preferably 3 inches thick, to a boxed-in sawdust pit with a canvas cover stretched over it. If a sawdust pit is used, there should be 6 to 8 inches of sawdust on the floor, boxed in by boards around the sides. A canvas should be pulled tightly over the area and securely tacked to the boards.

Cotton mattress-type mats, preferably not less than 3 inches thick, are satisfactory. However, the most common method used where a regular wrestling mat is not available is to lay gymnasium mats alongside and secure to each other and cover them with a mat cover. The cover should be pulled tightly over the mats and either tucked under the mats or, preferably, securely fastened to the mats with grommets and lacing. Wrestling on rough canvas will often cause mat burns.

White duck fabric should be used in the construction of the mat. The suggested size for maximum usage and easy handling is 24 feet square. It should be stuffed with not less than two layers of 100 per cent pure goat hair felt. Less expensive mats may be felted with pure Grade A hair felt. Both types of mats should be not *less* than 2 inches, and nearer 3 inches, thick. The edges should be square and have hidden seams. Tufts should be placed approximately every 6 inches, or less, and drawn tight.[6]

Mat Covers

The best mat covers are made of plastic, moleskin or heavy canton-flannel materials. A single cloth mat cover larger than 30 feet square is inadvisable because of the difficulty in laundering. Very few mats are larger than 30 feet square, but, if such mats are available, single mat covers should be fastened together to provide a mat covering.

Rubber mat covers can be used instead of cloth covers. The initial cost is quite high, but, because of their durability and wearing qualities, the cost is spread over a period of several years. Many wrestling coaches consider these mats unsatisfactory since the rubber prevents or restricts free movement when moving or sliding around on the mat. Rubber covers do have the important advantage of cleanliness, since they can be washed with a mild antiseptic solution each day, if needed. A zinc stearate or other antiseptic powder can be sprinkled over the mat to overcome some of the friction and to provide a sterilizing agent.

[6] United States Office of Quartermaster General, *Mat, Wrestling,* September 1, 1944, p. 1.

The third and newest type of mat cover is one made of vinylite plastic. High school and college coaches who have used it say that it is superior to the fabric cover because of its sanitary features. Soap and water will remove most of the dirt, and carbon tetrachloride or some other cleaning fluid will remove the remainder, including the black rubber burns from scraping or dragging shoes. In addition, it is pointed out that the contestants cannot receive mat burns nor is talcum powder needed to allow free movement as it is on many rubber mat covers. The tensile strength (ripping strength) is approximately 300 pounds per square inch, and many high school and college varsity wrestling squads have used the same mat cover for three or more years. Initial expense is high, but cost of maintenance is almost negligible.

Protective Supporters

For all class or intramural wrestling, a regular 3 inch or 6 inch elastic supporter will provide the necessary protection. For varsity wrestlers, specially knit supporters are available.

Helmet

Wrestling helmets made of flexible calfskin or cowhide and with special ear tabs of foam rubber are available and are used by some colleges.

Uniform

Wrestling apparel must be close fitting and resistant to abrasion due to friction against the floor, or to body movements of the wearer or opponent. It must also be strong in fabric and construction, especially at the seams. With the exception of the items listed here, wrestling costume is the same as that worn for gymnasium activities (see Gymnasium Costume, pages 288–298).

PANTS. Formerly, only long black tights that extended from waistline to feet were standard wrestling costume. These were worn with sleeveless, cotton knit shirts. Now, form fitting pants, similar to swim trunks, are worn over the tights. Some pants (trunks) have drawstring closings at the waistline. Preferable are the wide elastic waistbands that give additional support. Many wrestlers have discarded the tights and wear only trunks. This custom is followed also in informal college wrestling programs and physical education classes.

SHIRT. Shirts are not usually worn in professional wrestling. Their use in college and high school programs varies with the requirements of the particular institution.

Official Rules for collegiate wrestling matches specify that:

> The uniform shall consist of full-length tights, an outside wrestling supporter or close-fitting outside short trunks, light heelless gymnasium shoes laced by means of eyelets, and shirts, if they are required in accordance with the following provision: The home institution shall decide whether shirts shall or shall not be worn; however, the visiting team or teams shall not be required to wear shirts unless they are so notified by the home management at least ten days before the meet. If shirts are worn, they shall be sleeveless; there shall be no fasteners of any sort on the shoulders, and they shall be fastened down at the crotch. (The shirt recommended is the V type, fastened underneath the crotch by small hooks and eyes).[7]

Shoes

Gymnasium shoes that are light and without heels are required (see Boxing Shoes, page 84).

Care And Repair

When transporting *mats* from place to place, do not drag them on the floor. Clean fabric-covered mats every week with a vacuum cleaner. Wash rubber-covered and plastic-covered mats daily if they are used daily. Repair immediately small rips and tears in the body or the handles of canvas mats. Depending upon their use, clean canvas mats about once every three months with a commercial mat cleaner. If the mat is badly worn, send it back to the factory where it can be recovered and the old filler can be used for the mat stuffing. Painting of mats has proven unsatisfactory, because the paint comes off when the mats are given hard usage or when they are scrubbed regularly. A painted mat also becomes hard, slippery, and often loses its resiliency. Use powder freely on rubber mats to reduce the friction encountered.

7 "Official Rules," *Official Wrestling Guide,* 1950, pp. 53–55.

CHAPTER VI

Fencing

Historians can estimate only the period in which fencing was devised as a means of warfare, but most are agreed that it was before the era of Christianity. It was not until sometime in the fourteenth century, however, that it was tried as a sport. For many centuries fencing was an art practiced by most of the European aristocracy, since no one knew when he would be challenged to a duel as a means of avenging an insult. Often it was a battle to death, but in the few fencing duels that are now a part of our modern society a little drawn blood is the signal of victory.

Fencing weapons have varied over the many centuries with styles and sizes changing with the types of civilization. It is claimed that a short sword with a bronze blade, dating as far back as 3000 B.C., has been found. Not much is known about the weapons of the early Christian era. The favorite weapon of the first German fencers was a heavy, awkward double-bladed sword that varied from 2½ to 3 feet in length.

Fencing as a sport gained rapidly in the fifteenth and sixteenth centuries, and with the growth came many claims of superiority for several types of weapons. Italians first used the rapier and soon other countries followed. Professional fencing masters opened special schools for teaching fencing, catering especially to the young noblemen. This movement, however, was slow to gain momentum in Eng-

land, and records show that at least one master was arrested for maintaining such a school. About 1570 Henri Saint-Didier gave names to the major movements in fencing, many of which have since become standard terms for the sport.

It was a little over 100 years later that a fencing enthusiast from the Polish nobility devised a new type of weapon, the first radical change in fencing weapons for several centuries. From this new type of weapon the present fencing instruments, épée, foil, and saber, were developed.

Fencing in the twentieth century is mainly an activity for sport and recreation, but occasionally there is a report of a duel to avenge honor. In the latter case, a referee usually is designated to officiate and declare a winner.

Equipment

Foil	Equipment bag
Duelling sword (épée)	Target
Sabre	Costume
Mask	jacket
Rubber tip	pants
Point d'arrêt	glove
	shoes

The foil, duelling sword and sabre are the three weapons used in fencing (see Figure 32). Variations exist in the styling of each weapon, depending on the requirements of the three leading fencing schools to which each may conform: French, Italian, or Spanish. All weapons, however, consist of the following fundamental parts: (1) guard, (2) blade, (3) handle (grip) and, (4) pommel (see Figure 33). The blade is tapered from the shoulder (the section that joins the guard) to the point. The wider, heavier section from the center of the blade to the shoulder is known as the strong or forte. The shoulder end of the blade joins the shank, one end of which is threaded (standard 12/24 thread) and extends into the guard and through a hole drilled the length of the grip. There the shank or tang is screwed tightly to the pommel, so that all parts of the weapon are firmly and securely united.

All fencing weapons are imported from Europe, mainly from Italy, France and England, and are usually hand forged. Only the deluxe blades are nickel plated. The grade of steel used in the blades and the excellence of the workmanship that goes into the manufacture of the weapons determine their quality. The temper and balance of top quality blades is better than in blades of lesser quality. Pur-

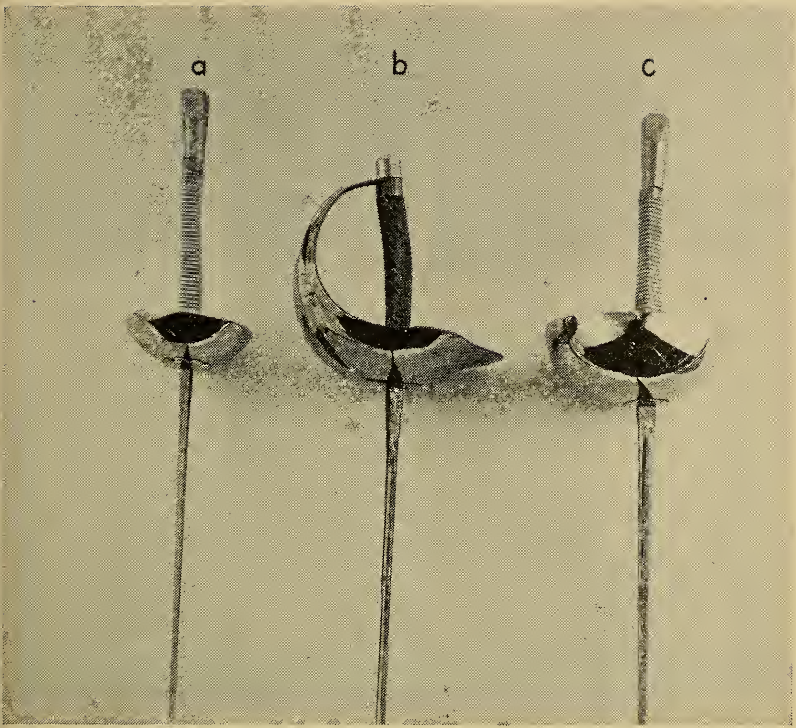

Figure 32. Fencing weapons: (a) foil, (b) sabre, (c) duelling sword (épée). (*Courtesy of Castello Fencing Equipment Company, Inc.*)

chasers cannot determine the quality of the steel (which is the low carbon variety) by visual inspection of the weapon and must be guided in their choice by the reliability of the manufacturer. However, the blade can be inspected for nicks and dents, and the balance can be judged by feel. In a well-balanced weapon the weight is balanced directly under the guard one inch from the shoulder. This is true of both the heavier weapons used in practice and the lighter weapons used in tournaments. The strength and flexibility of the blade can be tested by executing various thrusts and parries. A heavier blade is stronger and more durable but the lighter blade has more flexibility, and can be handled with greater ease. All blades should be sufficiently sturdy not to bend in the strong when the fencer thrusts or when the opponent's thrust is parried. The section

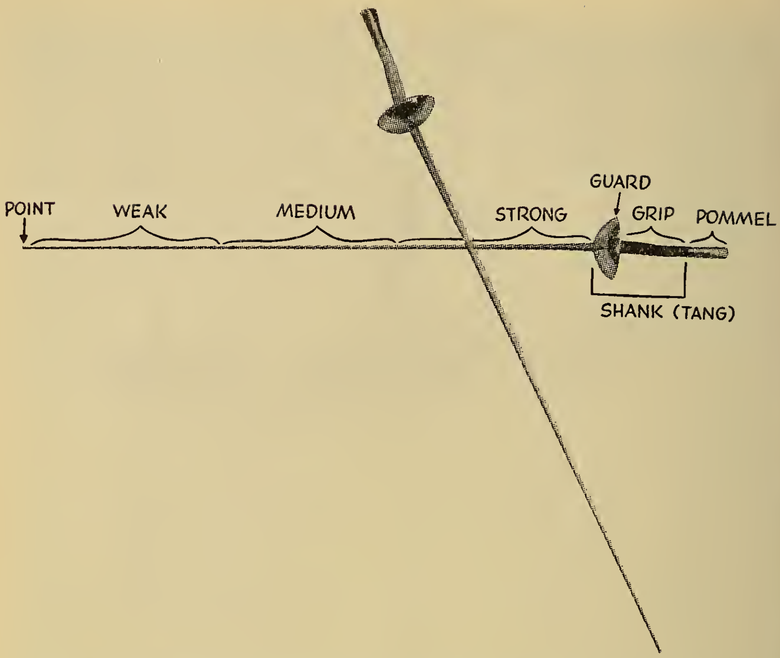

Figure 33. Standard parts of a fencing weapon. (*Courtesy of Castello Fencing Equipment Company, Inc.*)

of the blade from the center to the button (tip) should be flexible enough to bend when the thrust touches the opponent and scores. One method of testing the strength of this portion of the blade is to place the button on the floor and rest a 2 pound weight on the end of the shank. The blade should take a slight bend. Fencers give their blades a slight permanent set so that the blades will always bend the same way when a touch is made. Blades may be secured in two lengths, #4 and #5. The #4 is the shorter blade.

The guard is made of steel or aluminum. Best quality steel guards are chrome plated. Aluminum guards are highly polished. Edges of guards are rolled so that the surface is smooth, not sharp. Steel guards are more durable and heavier than the aluminum guards and may therefore be preferable for practice, but the lightness of the aluminum guards is preferred by fencers for tournament competition. The guard should be reinforced at the hole where guard and shank meet.

Handles may be wood or polished aluminum (Spanish style) and covered with leather or cord. Aluminum handles are more expensive

than wood handles, and leather covering is more expensive than cord covering. A lock washer that locks the pommel to the shank so that it will not shake loose is used on aluminum handles. Pommels are chrome plated, and in addition to screwing tightly to the shank and uniting the various parts, the pommel serves mainly to balance the weight of the weapon. An ornamental pommel contributes to eye appeal, but adds nothing to the performance of the weapon. Handles, guards, blades and pommels may be purchased separately for use on any of the three fencing weapons.

Foil

Of the three fencing weapons, the foil, considered basic, is used by the majority of fencers. Women fence almost exclusively with the foil. It is a light thrusting weapon and may be manufactured according to the designs of the French, Spanish, or Italian schools. Differences in the foils of these three schools exist mainly in the handle. The French foil (see Figure 33) is used more frequently than either of the other two. It has a slightly curved handle and is designed for the execution of quick, deceptive movements. On this type of foil the fencer can adjust his grip to gain additional length. The Italian foil has a short handle and a cross bar, and therefore permits a stronger grip. Foils that are modeled on the designs of the Spanish school (these include Spanish, Belgian and American foils) have polished aluminum handles with two or three prongs for gripping. Similar to the Italian foil, this type handle enables the fencer to have a better grip and stronger control of the blade. The pistol grip used on Belgian model foils fits the hand and adds strength to the fencer's parry but lessens his dexterity in attack.

Blades are slim, flexible and rectangular in section. They taper to a blunted point. The shank of the Italian blade is flat and is used as a grip; the shank of the French and Spanish type blades is square and is covered by the handle. There are no differences in the foils used by men and women. Some specifications for foils are listed in Table 9. A rubber tip should cover the tip of the foil. These tips are inexpensive and much safer than adhesive tape, which can be used but must be thick enough to give adequate protection, and requires constant checking to see that the blade is not wearing through the covering.

Duelling Sword (Épée)

The duelling sword is a descendant of a small, eighteenth century sword used for duelling (see Figure 32). Like the foil, it is a piercing

weapon, and may conform to the design of the Spanish, French or Italian schools of fencing. Some dimensions of these weapons are listed in Table 9. Duelling swords may be obtained with center or off-center guards. The sword with a center guard is a better balanced weapon, but the off-centered guard gives greater protection against hits that land on the arm or hand. A point d'arrêt may be attached to the tip of the blade. This three-pointed attachment catches on the jacket, and touches are recorded more readily.

Table 9

DIMENSIONS FOR FENCING WEAPONS[1]

Dimensions (maximum)	*Foil*	*Duelling Sword*	*Sabre*
Weight	17.637 oz.	27.160 oz.	17.637 oz. (max.) 11.464 oz. (min.)
Length (overall)	43·307″	43·307″	41·338″
Blade length	35·433″	35·433″	34·646″
width	0.944″	0.944″	0.047″
Guard (diameter)	4·724″	5·415″	5·905″ x 5·512″
Hilt (length)	9·134″	9·134″	9·134″

In matches where touches are registered by means of an electrical apparatus, the electrical duelling sword is used. The connectors should be constructed so that they cannot become accidentally disconnected during a bout. Parts should be accurately machined and interchangeable. Ease and speed of repair during a meet is important, since weapons may become damaged in combat.

Sabre

The majority of touches are made with the cutting edges of the sabre rather than with the point. However, it is both a piercing and a cutting weapon (see Figure 32). There is considerable variation in the design of sabre guards. A wide guard gives greater protection to the hand, and is more durable than the Hungarian model guard which is lighter and narrower. Handles and blades do not vary in design, except that blades may be secured with either a T or Y shape cross section. The T shape is more durable, but the Y shaped blade is lighter and more flexible. Some specifications for sabres are listed in Table 9 .

[1] Amateur Fencers League of America, *Fencing Rules,* 1940, pp. 73–81. Other very detailed specifications and requirements concerning equipment are given in the rules.

Mask

A mask is worn by all fencers to protect the head and face. It should be durable, light, well fitting, and provide complete protection at this area of the body. The fencer should have a clear, broad angle of vision through the mask. Masks are made of steel wire mesh very closely interlaced (approximately 8 squares to the inch), so that a blade cannot pierce the mesh even if the tip of the blade breaks off

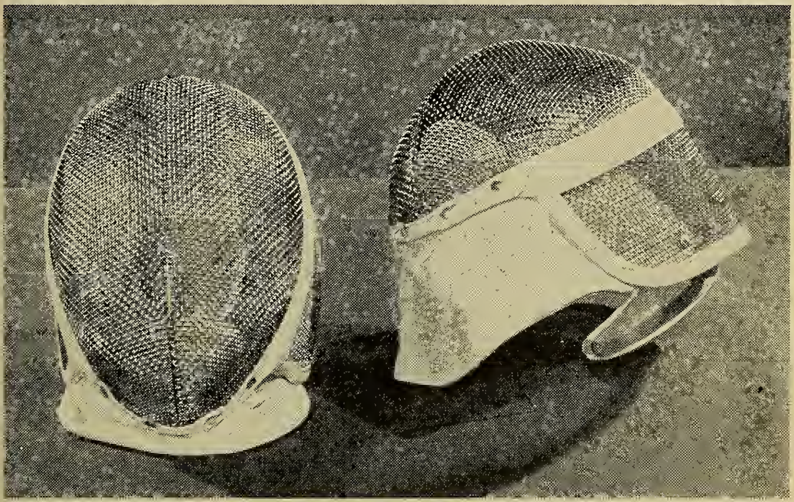

Figure 34. Masks: front and side view of foil mask with bib attached by means of gripper buttons. (*Courtesy of Castello Fencing Equipment Company, Inc.*)

(see Figure 34). A stronger mesh is used in masks worn when fencing with the duelling sword to protect against the harder impact of the point d'arrêt. Sabre masks are reinforced over the face area, and are covered with leather or washable leatherette (over a felt padding) to protect the fencer from the heavier blows of the sabre and the whipping action of the blade.

Canvas bibs that protect the neck are attached to the inside of the mask. These should be easily removable and washable. For this purpose, bibs that button (snap button) on to the mask are preferable to the type that is sewn. The chin piece should be padded. Bibs can be purchased separately when new ones are needed.

The mask is held onto the head with a padded back spring attachment. Canvas (heavy), leather or leatherette are used as trimming on

the mask. The latter two materials are easier to clean than the canvas. A leather trim is more expensive than leatherette.

The wire in the mask may be painted or have a tinned or chrome finish. The latter two finishes are preferable, since they do not require further treatment to keep the wire from rusting. Moisture from perspiration, in the atmosphere, or as a result of the fencer's breathing may rust wire that has not been tinned or chrome plated.

Additional Items

Rubber tips may be purchased for foil blades. These should always be used for practice and instruction periods. Points d'arrêt that are used on duelling swords should have three hardened points so that they do not blunt easily. Equipment bags that carry all items of equipment are manufactured in durable, waterproof canvas. The sides and bottom of the bag are reinforced. Bags have slide fastener closings, and a carrying strap is attached to one side. Some bags are designed to hold only one weapon. Targets covered with strong, heavily padded canvas over a hardwood base can be used for practice.

Costume

Clothing worn for fencing must be primarily protective. It should also be close fitting, so that movement is unrestricted, the blade does not catch in the garments, the fencer has a clear view of all body areas of attack, and the judges can readily determine when points have been scored. For these reasons, in tournament competition, both men and women usually wear jackets, pants, gloves and fencing shoes. The costume is white or natural in color (see Figure 35).

JACKETS. For practice purposes, a plastron may be worn. This white, quilted pad covers the chest, waist and side on which the weapon is held. A waist and shoulder strap hold the pad in place and can be adjusted to any size. However, the plastron does not cover the neck and underarm area of the body, and is not recommended unless the budget does not permit the purchase of half-jackets. The instructor sometimes wears a plastron over a full jacket.

Half-jackets have one sleeve (double thickness) and a high collar that fits securely around the neck. Adjustable straps (and buckles) at waist and chest height keep the jacket in place. A canvas strap on men's jackets insures protection of the groin. Some jackets have a triple thickness at the neck, underarm and chest. Half-jackets cost less than the full jackets.

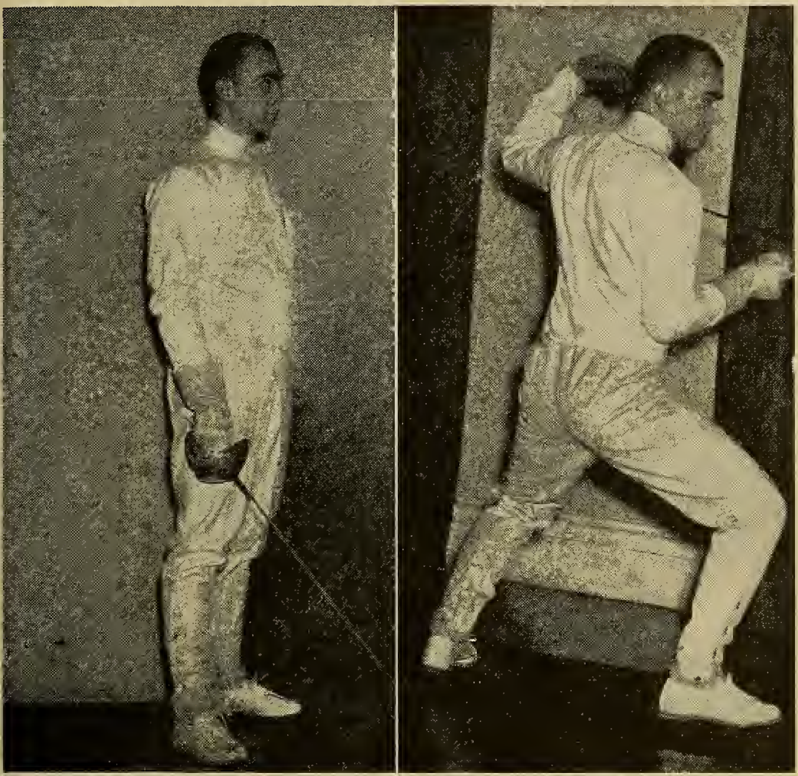

Figure 35. Fencing costume: front and back view of costume worn by men and women when fencing with the foil. (*Courtesy of Castello Fencing Equipment Company, Inc.*)

Full jackets that completely cover the upper part of the body, front and back, and both arms are used in tournament competition. These are made of close weave canvas (army duck) or, for women, gabardine or twill may be preferred. All jackets may be purchased in standard sizes or custom made. The sizes of standard jackets represent chest measurements. Jackets may be purchased for either right- or left-handed fencers and this difference should be specified when jackets are ordered. An extra practice sleeve that buttons over the jacket sleeve may be purchased separately for use when practicing with a duelling sword that has a point d'arrêt. A quilted canvas cupped elbow protector may also be purchased separately for use in sabre fencing.

Men. Jackets for men have a double or triple thickness in the front and in one sleeve (fencing arm) that is also reinforced at the armpit. Foil jackets are waist length. An all-purpose jacket useful for wear in all types of fencing is longer, and has a canvas strip that fits between the legs. Buttons should be unbreakable.

Women. Women's jackets are waist length and have a specially padded front. Jackets may be provided with chest protectors, or these can be sewn into the jacket after they have been purchased separately. In the latter case, the jacket should be provided with pockets into which the protectors can be sewn. Chest protectors are light wire mesh or padded canvas. In formal competition the jacket must include a dark ribbon to mark the horizontal line passing across the tops of the hip-bones.

PANTS. For informal fencing, shorts are frequently worn by both men and women. In formal competition, full-length pants are customary. These are styled for either left- or right-handed fencers. Standard sizes represent waist measurement, but custom made pants may be secured. Buttons should be unbreakable.

Men. Heavy army duck pants in either knicker or trouser style are worn by men. Trousers button at the side and at the outside lower leg. They extend to the ankle, and are worn with ankle length hose, usually wool and cotton. The pants are well-tapered for smooth, close fit. Gathers at the knee permit ease of leg flexion. Knickers are less tapered, and have elastic in the bottom of the pants leg. Knee-length cotton hose are worn with knickers. Both types of pants have a strap at the center back of the waistband for adjustment in size at this section.

Women. Ski-styled pants are worn by women. These may be purchased in either twill or gabardine.

GLOVE. Only one glove is used in fencing. This is worn on the hand that holds the weapon since the other hand is out of range of contact and does not need this protection. The glove is a gauntlet type with a cuff that extends above the wrist, and is straight cut to fit closely and firmly to the arm. Large cuffs are prohibited by the official fencing rules. The palm of the glove should be soft in order to grip the weapon securely and comfortably. The back of the glove should be of durable and firm leather. A soft chamois or capeskin is usually used on the palm, and horsehide on the back. Gloves are similar in pattern to a gun-cut glove. Omission of seams at sides of

fingers and thumb assures added durability and comfort. A duelling sword glove must be strong and firm enough to protect against the contact of the point d'arrêt. The cuff of a sabre glove is padded to absorb the blow. Gloves are manufactured for either the right or left hand, and may be secured in small, medium and large sizes. Leather or canvas cuffs that can be slipped over a foil glove for sabre fencing can be purchased separately.

SHOES. White leather oxfords with a supporting strap across the front are worn for fencing. Rubber or chrome soles and cushioned heels are desirable. Sneakers are suitable substitutes for oxfords.

Care and Repair

Most repairs or reconditioning of equipment must be done by the manufacturer who is set up to handle such problems. However, a few suggestions for care and repair of weapons and masks are included here.

Weapons

1. Put a slight set on the blade before using it so that it will always bend in the same direction. This can best be done by resting the tip of the blade on the floor, placing the foot halfway up the blade, and drawing the blade towards you. Keep the blade as close to the floor as possible and draw gradually, otherwise the blade may break.
2. Straighten a blade that has been bent out of position by a heavy thrust or incorrect storage, by drawing it evenly between the foot and the floor. Any other method of straightening may put kinks in the blade.
3. Remove small nicks in the blade with fine emery cloth.
4. Keep the pommel screwed down tightly to prevent the guard from becoming misshapen.
5. Wipe off the blade periodically during very humid weather or in damp climates.
6. Oil the blade occasionally so that it won't rust.
7. Replace broken blades by unscrewing the pommel and slipping the old blade out. A new blade may require filing before it fits correctly.
8. Store weapons in a dry storage place, room temperature.
9. Store weapons by suspending them from wall brackets with the weight of the weapon on the guard which rests across the bracket.

Masks

1. Repaint masks on which the paint is wearing off. Masks that are tinned or chrome plated do not require treatment of any kind except wiping out with soap and water.

2. Wipe out masks frequently with warm water and soap, or cleaning fluid.

3. Launder bibs frequently.

4. Clean leather trimming with saddle soap. Leatherette trimming can be wiped off with warm water and soap. Stains on leatherette, such as lipstick, may need to be removed with cleaning fluid. Canvas trimming can be cleaned with soap and water or cleaning fluid.

5. Store masks so that the weight of the mask does not rest on the back spring. Two masks can be fitted into each other for conservation of space. Storage space should be sufficiently large to store masks without outside pressure being exerted against them to press them out of shape.

CHAPTER VII

Field Hockey

A game with some of the basic ideas of field hockey was known to ancient nations, and some historians agree that field hockey may be the oldest known stick and ball game. It is thought that the first equipment consisted of a tree branch and a large pebble. For many centuries the game was known only as hockey but it was finally changed to field hockey to differentiate it from a somewhat similar game played on ice. Little is known about very early field hockey equipment, but it is believed that round pieces of wood supplanted pebbles as the ball used for the game.

In the United States field hockey is not considered a popular sport for men, but it is an important part of the women's physical education program. The game is played by both men and women in many foreign countries.

Equipment

- Stick
- Ball
  - practice
  - game
- Shin guards
- Goal guards and foot pads
- Costume
  - uniform
  - hose
  - shoes
  - jacket
  - warm-up suit

Field hockey is usually played on a grass field except in those areas of the country where the only available playing space is a hard dirt surface. Dirt fields are used also in college and university field houses. Although the game is generally played in the cool, brisk fall days, games take place occasionally in rain, snow and extreme heat, depending upon the section of the country and weather variables. Most of the equipment comes from England where the game is more widely known and played than it is in the United States.

Stick

Sticks must have impact strength and flexibility in order to (1) resist breaking on impact with the ball or other sticks; (2) give sufficient impetus to the ball; and (3) resist chipping and denting on the

Figure 36. Field hockey stick. (*Courtesy of General Sportcraft Company, Ltd.*)

hitting surface. Varied playing surfaces and climates require the use of materials that are resistant to moisture, dirt and changes in temperature. Sticks should be light enough to prevent undue fatigue on the part of the player (see Figure 36).

Official rules place certain restrictions on the material and type of construction that may be used in manufacturing sticks.

> A stick shall have a flat surface on its left-hand side only. The head of the stick (that is, the part below the top of the splice) shall not be edged with, or have inserts or fittings of any substance other than wood, nor shall there be any sharp edges or dangerous splinters. The extremity of the stick must not be cut square or pointed, but must have rounded edges.
>
> Umpires shall prohibit play with any stick which does not comply with this rule.
>
> *No left-hand sticks may be used.*[1]

The heads of top quality sticks are made from ash that has a well-

[1] "Official Rules," *Official Field Hockey-Lacrosse Guide,* 1950–52, p. 74.

defined, straight grain. There should be four to six grains to the inch. Tests carried out by the British government Department of Scientific Research show that English ash is superior to American ash in specific gravity, elasticity, weight and strength. In tests for impact and tensile strength it was found that fast-grown ash (4½ rings per inch) required 50 per cent more energy to cause failure than the slow-grown specimen (8 to 10 rings per inch). Mulberry is used in medium quality sticks. It does not have the strength of ash. The wood should be free from knots and without discoloration. The contour of the head varies slightly with different manufacturers. The toe may be rounded or square, the back of the head slightly rounded, or bulger type (a pronounced curve) for driving power.

In better sticks, the handle is made up of four or more pieces of laminated cane (Indian cane is brittle. Best quality cane comes from Sarawak, Manila and Malacca) with three rubber insertions running almost the length of the handle. These insertions help to minimize shock to the player when the stick contacts the ball, and are evident at the top of the butt end of the stick. Some sticks have handles of cane laminated with ash. In the cheaper models the handle consists of fewer laminations and rubber insertions. A handle that is too thin breaks easily. The minimum diameter of the handle 6 inches from the top of the knob should be about 1⅛ inches. For protection against shock and better grip, the handle has a light covering of rubber. On some sticks this grip is removable, and, when worn out, can be purchased separately and placed on the stick by the player. Extreme heat will cause the grip to rot. Grips vary from 15 to 18 inches in length.

The flexibility of the handle can be tested by bending the stick slowly and carefully with the hands, while keeping the stick in contact with the ground and the hands placed at top and lower part of handle.

To check the straightness of the wood, hold the stick at eye level with the toe pointing up and glance down the length of the stick. Deviations from this straight line may indicate a warped wood.

The section of the stick where the handle joins the head (splice) is not visible to the player. It should be well-fitted and smoothly joined. Better sticks have a vellum (rawhide covering) over the splice to give greater strength, or are reinforced with linen tape or cord, or both. Linen tape may also be used to secure the grip.

Trimmings in different colors may be added to the stick. They contribute to appearance and may increase the cost of the stick, but do not affect the performance in any way.

In the United States most players use a 36 inch, 18 ounce stick.

Defense players may prefer sticks that are heavier than average (19 to 20 ounces) for stronger support for tackling and good clearing drives. Elementary and junior high school players generally use a 34 to 35 inch, 16 to 17 ounce stick. To determine correct length, players should be able to hold the stick comfortably in dribbling position, and to swing the stick easily for a drive. If the player must assume an unusually upright or crouch position during the execution of these strokes, the stick is either too long or too short. Classification of sticks as to length and weight is indicated in Table 10.

Table 10

LENGTH-WEIGHT MEASUREMENTS FOR FIELD HOCKEY STICKS

Long—37 inches to 38 inches	Heavy—19 ounces to 24 ounces
Medium—36 inches	Medium—18 ounces
Short—34 inches to 35 inches	Light—15 ounces to 17 ounces
Junior—30 inches to 33 inches	

In summary, a good stick can be recognized by conformance to the following specifications:

1. Handle—all cane built up from four or more pieces of cane; reasonable flexibility.
2. Rubber insertion—about 12 inches, 9 inches and 6 inches.
3. Crook (head)—well-defined, straight grain, 4 to 6 to the inch.
4. Wood—free from knots and discoloration.
5. Splice—well-fitted with perfect intimacy of contact between the two parts (handle and head).
6. Finish—a badly finished stick is often a sign of bad workmanship.

Ball

Both game and practice balls must be durable and resistant to abrasives in order to withstand the impact of the stick and contact with ground and goalposts. Weight must be sufficient to prevent balls from rising dangerously into the air from correctly executed strokes. Balls will naturally rise on scoops, some flicks, and as a result of undercutting. Resistance to moisture, heat and cold are equally important properties of good balls (see Figure 37).

Official rules specify that

> The cover of the ball shall be of white leather. The inner portion of the ball shall be of cork and twine. The weight of the ball shall be not more than 5¾ ounces and not less than 5½ ounces. The circumference shall be not more than 9¼ inches and not less than 8¾ inches.

Umpires shall forbid the use of any other ball. . . .

Balls made of composition or plastic are forbidden by this rule for use in games. They may be used for techniques.[2]

GAME. Game balls of top quality are those that have ninety stitches to the row and are sewn in four pieces. The cheapest hockey balls have only sixty stitches to the row, have dummy reinforced seams, and are sewn in two pieces. Qualities in between have more or

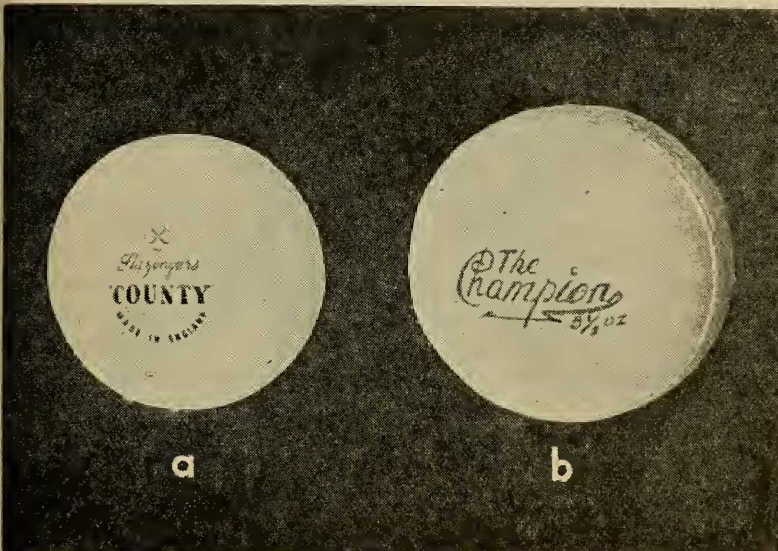

Figure 37. Field hockey balls: (a) practice ball, (b) game ball. (*Courtesy of General Sportcraft Company, Ltd.*)

less stitches to the row, and only the expensive balls are sewn in four pieces. The advantage of sewing a ball in four pieces is that, if so constructed, it is more likely to retain its shape, there being less tendency of the leather stretching in a small area. A comparatively recent innovation in hockey balls is the seamless ball with a molded rubber cover, or, in certain instances, a molded leather cover. This ball has the advantage of not splitting under constant usage. The covers of some seamed balls have split at the seams, and the balls have been rendered useless before the leather itself has worn out. A better quality of leather is used in top quality balls. Cheaper, inferior balls are made from belly hide, which has greater tendency to

[2] *Ibid,* pp. 74, 75.

stretch. There are also certain differences in the quilt or core in the cheaper balls; more cork is used in proportion to the worsted winding than in the higher qualities.

An under-coat of white paint is first used, over which is painted a final coat of ordinary hard-gloss enamel. Game balls are always painted white, except for games played in the snow, when red or orange painted balls may be needed to distinguish them from the snow. During the course of manufacture, a waterproofing finish is applied to the better quality balls, and a waterproofing solution to the cheaper balls. Game balls are considerably higher in cost than practice balls.

PRACTICE. Cork or a cork and rubber composition is used for practice balls. They do not have a leather cover, and are lighter than game balls. Rubber balls do not approximate the feel and action of regular game balls and are therefore less ideal than a composition ball, especially for beginners. An innovation in balls is the plastic-covered ball. It is claimed that this ball is impervious to moisture, will retain its shape and weight, and does not require repainting. So far it has been used only as a practice ball, and is much more expensive than other practice balls. If practice balls are painted orange or red they will not become confused with the game balls.

Shin Guards

Shin guards fit over the front of the leg extending 10 to 12 inches above the ankle (see Figure 38). They are fastened on the outer side of each leg by means of leather straps and buckles. Guards should be lightweight and sufficiently pliable to fit closely to the leg. Protective foot pads, attached to the leg pad, are held in place by an elastic strap that fits under the instep of the hockey shoe. A sturdy, durable fabric (or other material) is needed to resist the abrasive action of sticks and balls. Best quality guards are finished in leather which lasts longer than canvas. Cloth guards are plain, or have a leatherette binding which adds to the cost of the guards. Guards must be well padded, and in the more expensive guards elk's hair is used as stuffing since it does not tend to bunch up as kapok does. Ribbing helps to deflect the blow of stick or ball. For this purpose cane, which is very lightweight, is used. Some guards have reed ribs.

Goal Guards and Foot Pads

Goal pads serve the same function as shin guards, and must have a thicker, firmer padding to protect the legs from hard, direct shots. Pads are necessarily much larger and wider than shin guards.

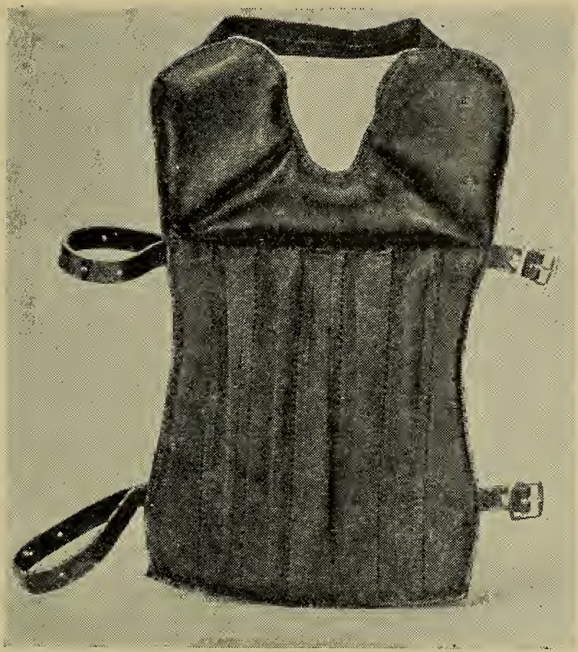

Figure 38. Field hockey shin guard. (*Courtesy of General Sportcraft Company, Ltd.*)

Guards and foot pads may be secured in a variety of styles (see Figure 39). However, Elliott offers the following suggestions which may serve as reliable guides for the purchase of goalkeeping equipment:

Equipment should afford adequate protection with a minimum of weight and bulkiness; most available equipment is far too cumbersome.

Shoes with hard box toes and cleated soles are essential, and equally important are extra foot pads or "kickers," which must fit snugly and closely over the shoes. The most practical "kickers" are made of soft leather, with a padding of sponge rubber and felt over the inside of the instep. Overpadded kickers impede hard or accurate clears and padding on the outside of the foot or over the heel is superfluous. A slice of ordinary rubber bath sponge, about 3/8 of an inch thick, placed along the side of the big toe under the sock, will help soften a hard shot and improve kicking.

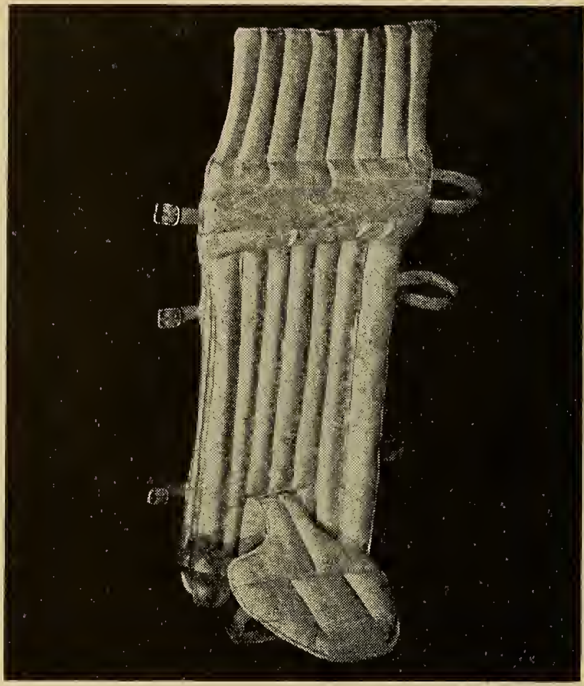

Figure 39. Goalkeeper's leg guard. (*Courtesy of General Sportcraft Company, Ltd.*)

Pads should be as light as possible and not so wide as to interfere with quick movement. They should extend slightly above the knee, but should have no straps around the thigh as these tend to hamper knee action.[3]

The quality of the fabric used as covering, and the size of the guards are factors that influence the cost of these items of equipment. Opinion varies on the need for guards, but from a safety viewpoint guards should be worn at all times, at least by unskilled players. Many players are ball shy, and their skill would be greatly improved if, through the use of proper equipment, they lost this fear.

Costume

Running and vigorous action of the arms and torso are the primary movements of the body in field hockey. There is considerable strain on the garment across the shoulders and chest. Freedom of

[3] Frances Elliott, "Some Fundamentals of Goalkeeping," *Official Field Hockey-Lacrosse Guide,* 1941, p. 19.

movement in elevation of the arms above shoulder level is not a primary consideration since the rules of the game forbid raising the stick above the shoulders.

Fabrics must be cool or warm depending on the section of the country and the time of year in which the game is played. In the northeast and midwest areas of the United States where participation in hockey is greatest, weather ranges from cool to very cold. In parts of the south and southwest temperatures may reach 100 degrees and over. By far the largest number of players are women, but in the east the sport is taught to boys and men in some private schools and colleges, and there are a few men's club teams.

Regular gymnasium costume, or a variety of styles in shirts and shorts are worn by boys and men. In cold weather, warm-up suits may be worn instead of or over the shirts and shorts. Socks and canvas or leather shoes with cleats complete the costume. For club hockey, long shorts and knee-length hose similar to those for soccer are frequently worn.

In many institutions, the regular gymnasium costume is worn by girls and women for field hockey. Shirts and shorts are worn by a number of club teams, some of whom have adopted the long short that has become the official costume of the All-English team. However, the traditional field hockey costume of tunic, blouse and belt (girdle) still prevails with most teams.

TUNIC. Traditional style tunic includes a square-yoked neckline and three box pleats front and back. A square-neck woven blouse (guimpe) with long or short sleeves is worn with this tunic. Corners of the guimpe neckline should be reinforced to prevent ripping at these sections. The belt is made of the same fabric as the tunic, although many players have begun to wear a woven belt of a contrasting color to match their socks. This belt ties in a bow and may hang to the edge of the tunic. Close-fitting trunks or tights, usually black or navy blue, are worn under the tunic. The princess style tunic (fitted and with a flared, unpleated skirt) has become increasingly popular. Variation of the box pleat, square-neck tunic and shirt include, in addition to the princess style, straight cut semifitted tunic without pleats, round or V necklines of both shirt and tunic, knit shirts.

Formerly, most tunics were made up in wool or rayon serge. At present, wool, cotton, linen and rayon are equally popular, depending on the climate and season of the year in which hockey is played. Shirts are usually white cotton broadcloth or a knitted fabric. Tunics may be secured in most solid colors and in different color values, light to dark.

Unless custom made, tunic and shirt sizes correspond to bust measurements and the length of the tunic is in proportion to this measurement. Average length is approximately 3 to 4 inches above the knee, measured from the ground as the player is in kneeling position.

BLAZER. For warm-up periods and after the game, a wool flannel blazer is part of the traditional costume. These come in solid colors, with white, navy blue, dark green and maroon predominant. A braid trim may be used on the pockets and around the neckline. School, college or club emblems are sometimes worn on the pocket.

WARM-UP SUIT. Warm-up suits are worn in cold weather. Some players play in the pants of these suits, although action is somewhat impeded. Woolen slacks are a good substitute provided they are fastened around the ankles to prevent tripping. Sweaters may be used in place of a warm-up jacket. Ski parkas and other style jackets with hoods afford good protection around the neck and head (see Warm-up Suits, pages 294–295).

HOSE. In cold weather women wear hip length black cotton stockings or tights under tunics, with wool anklets worn over the stockings. Teams from the British Isles frequently wear stockings or tights that are colored to match their tunics. Ankle length socks of cotton or wool are worn in warm or cool weather.

SHOES. Since hockey is played on a grass field that is frequently slippery, it is essential to the maintenance of good balance that shoes have cleats. These should be molded in one with the rubber sole or they may pull off. Uppers may be canvas and are usually black. A shoe with an additional piece of canvas across the top of the instep gives extra support to the foot. Some shoes feature cushion insoles and arch cushions. Shoes should always be bought a size larger to allow for wearing over heavy wool socks. Figure 40 illustrates one type of canvas hockey shoe.

Leather shoes (both uppers and soles) are preferred by some players especially for rainy weather. Leather cleats are nailed to the soles. Shoes with metal cleats, metal spikes or projecting nails are not permitted.

Leather shoes with heavy leather box toes and leather cleats on the sole are needed by the goalkeeper for stopping hard shots and clearing the ball with the feet. These shoes may be padded at the sides and over the instep for additional protection. These shoes are similar to the leather football and soccer shoes worn by men.

Care and Repair

The following procedures in care and repair of hockey equipment are recommended.

Stick

1. Keep the head of the stick clean. Scrape off mud or dirt with a knife or steel wool, and wipe the wood with a slightly dampened cloth.

2. Allow the stick to dry naturally after any wetting. Artificial heat causes the wood to dry out too quickly and become brittle. Such sticks frequently splinter or break when used.

Figure 40. Field hockey shoes for women. (*Courtesy of the U.S. Rubber Company.*)

3. Do not use oil on *ash* heads, as it softens the wood and lifts the grain, and as a result the head may split. (Exception: when sticks are to be stored at the end of a season, a *small* quantity of linseed oil can be applied on the face of the head.) Instead, apply a preservative varnish or wax after the surface is cleaned. This acts as a water repellent and protects the wood from dust and dirt; it should be done soon after a new stick is used since the cellulose preparation that has been applied in the factory wears off quickly. Apply preservatives with a small brush or pad made of cotton wool. A thin coat only is necessary. This should be done sparingly after each game.

4. Heads made of *mulberry* are improved by oiling. The stick should be clean and dry before the oil is applied. Varnish the back of the stick and wax the playing surface after the oil has been absorbed and the surface is not moist or sticky.

5. Avoid sitting or leaning on the stick or placing the entire weight on it when testing its resiliency.

6. Wipe the grip with a damp rag before the stick is put away. Perspiration and oils from the hands may, after continual usage, gradually damage the rubber grip.

7. Store sticks away from direct damp or heat. Ordinary moisture content of the air is good for sticks and they may be stored in any temperature from freezing to 90 degrees without harm, provided the temperature is even, and that natural, not artificial, heat is used.

8. Storage of sticks in an upright position with the weight of the stick on the head or end of the handle may cause the wood to warp. The best method is to lay sticks flat without the pressure of other sticks on them. Placing sticks across two pegs driven into a wall or in a cabinet is an excellent method of storage.

9. Sandpaper rough edges of sticks. Glue or tape edges that are split or splintered before the stick is used again. For this purpose, a surgical tape is advised. If the tape is cut at regular intervals as it is applied to the edge, it will fit smoothly. Winding the tape around the head is unnecessary.

Ball

1. Leather-covered balls have an enamel coat which chips off during play. Without this protective covering, balls are subject to soaking if used in wet weather or on a damp field. They should be reenameled whenever this coat is worn off. Apply fresh paint after each period of use. In order to promote quick drying of balls, a problem that has prevented many schools from painting balls more frequently, use a quick drying enamel. If balls have become water soaked, allow them to dry out before paint is applied. Previous to painting, scrape off all old paint. Denatured alcohol or a suitable paint thinner, and fine or medium-coarse steel wool are suitable for this purpose. Unless the old paint is removed, the ball becomes heavy, and uneven in circumference. A board into which nails have been driven part way will serve as an excellent place on which balls can be painted and dried. An alternative method of painting is to hold the ball in a metal clip and dip it into the enamel, then place it on the nail rests to dry.

2. If a game is played on a wet surface, the use of a number of balls during the game will prolong the life of each ball. Continual play with a wet ball causes it to wear out prematurely. Moisture soaked balls should dry out naturally. The application of any form of artificial heat will cause the leather covering of game balls to crack and split.

3. Store in an even temperature away from dampness. Ball bags of different colors (one for game balls, one for practice balls) may be

used for both storage and transportation of balls to and from the field. Some instructors prefer to have several sections of a cabinet marked for ball storage. Balls are placed in rows and can be counted easily. Paint is not rubbed off and this is an efficient method of storage in those classes where each player is responsible for taking a ball to the field rather than having to wait for one appointed person to bring out all balls in a bag or box.

4. Inspect balls regularly for (1) ripped seams of the leather covering on game balls (it may be possible to have the cover stitched at a shoemaker's shop); (2) scarred, uneven surfaces of composition balls. These balls should be discarded if they are badly worn because they become too light, and on hard drives may rise dangerously. If stick-work practice is held indoors during bad weather, the balls may be covered with fabric and used for indoor practice.

Shin Guards and Goal Guards

1. Allow wet guards to dry before putting them away.
2. Remove dirt or mud that has dried on the guards with a good, stiff brush.
3. After use, attach matching guards to each other, store in pairs, and place flat on a level surface. When guards are hung on pegs, the elastic understrap is weakened and stretches out of shape.
4. Oil leather straps occasionally to prevent drying out and cracking. The frequency of oiling depends on the temperature of the locality in which hockey is played. In very hot climates more frequent oiling is required.
5. Leather straps, elastic understraps, and buckles that pull off can be repaired at a shoemaker's shop. In some places, harness shops have done an excellent job of repairing shin and goal guards. Buckles can be purchased from these shops and from some hardware and dry goods stores.
6. Buckle guards on the outside of the leg to prevent irritation of the inside of the leg and possible tripping.
7. Repair damaged guards at once. This is especially true in cases where one of the leather straps is in need of repair. A loose guard can trip a player very easily. Players should remove and hand in guards for repair as soon as they become damaged. It is well to have several extra sets on the field in case any guards are damaged during play.
8. Check the ankle understrap for rips or overstretching. These, also, can cause a player to fall unless they fit securely. Leather straps that are too long should be cut off to a suitable length adjusted to leg size. Additional holes can be made in the strap with an ice pick.

CHAPTER VIII

Football

Football as played in the United States today may be traced to a wide variety of violent, brawling ball games which achieved popularity in England. Known variously as camp-ball, football, and huling, these early sports were often little more than disorganized free-for-all battles.

Although the game has grown in popularity over the past three decades, it has constantly encountered obstacles when injuries created great public resentment and caused some schools to abandon the game. Partly through the efforts of President Theodore Roosevelt, an enthusiastic supporter of the game, the first steps were taken during his term of office to transform the game into one of skill and speed. The change in rules, the trend toward the professional coach, better officiating, pregame training and, above all, the development of newly designed equipment, were all responsible for the new popularity.

In the early days of football the uniform consisted of a sleeveless laced jacket, or vest, and padded pants. Cane-reed shin guards were introduced into the game to protect legs and ankles. The shoes were heavy, usually made of tan or black calfskin. The first cleats were made of wood, oblong in shape, nailed on and trimmed by hand. Usually three cleats were affixed to the heel and seven on the sole. The only real protective equipment for the head and face was a rubber nose guard, designed to cover the nose and teeth. The play-

ers' hair, long and as thick as possible, served as the first head protector. Later, crossed round leather bands, stuffed with cotton, were used. This model was the forerunner of the modern football helmet. Quilted padding, sewed to the outside of the jersey and over the shoulder and elbows, provided some protection against bruises and injuries. For shoes, the first mud cleats appeared about the same time. Further experimentation and research led to the development of curved fiber pads. Such pads were set into pockets of football pants for thigh protection, and used around the waist for protection over the kidneys and hip bones. The shoulder pad was improved by covering it with leather, and later, leather and fiber to give more protection to shoulders and collar bones.

Since head injuries were probably the most serious, the development of the proper head protection was urgent. The cotton stuffed construction was followed by a hat-type helmet, lined with felt. About 1922, a sponge rubber ring was placed in the crown of the helmet and this led to the use of rubber over most of the inside layer. The outside covering was made of heavy leather. About ten years ago, the first molded plastic helmet was put into use. Further development improved the helmet and its safety to the wearer, but also precipitated the current dispute as to its injurious effects upon opponents. Recently the chairman of the Football Rules Committee announced that the plastic helmet now in use was dangerous, and that it would not be permitted after the 1949 season.

The first successful removable cleats were introduced about thirty years ago and were made of either molded rubber or bakelite. Many changes in shoes and cleats have followed since then, most of them designed to provide more protection for the player.

Equipment

(over)

Headgear	Uniform
Shoulder pads	jersey
Hip pads	pants
Knee pads	hose
Blocking pads	jacket
Injury pads	shirt
Ball	shorts
	shoes
	warm-up pants (suit)

Safety should be of primary importance when selecting football equipment because of the possibilities of serious injury. Football is the most hazardous of the intercholastic and intercollegiate sports.

Particular care is necessary in the selection of helmets, pads and shoes. Prior to the use of plastics and molded fibers there often was a high correlation between the weight of, for example, a helmet and its safety features. Now, however, weight and bulk alone cannot be considered sufficient criteria for selection. Materials used and methods of construction are important, but so too is the proper fitting of equipment to each individual athlete.

There is still a great need for more research and improvement of football equipment, but some of the recent developments have included: locking devices that prevent cleats from coming off; elastic web belts to keep pants more secure around the waist; special types of blocking pads; better constructed shoulder and hip pads; helmets with suspension hammocks to prevent contact of the head with the crown of the headgear; thigh guards of plastic and overlapping sponge-rubber knee pads; protective blocking uniforms for a live blocking practice.

Headgear

Probably the most important piece of equipment for the football player, from the standpoint of preventing serious injury, is the headgear. There has been a tendency to make headgear lighter in weight, larger and harder in the past few years in an attempt to curb the increasing number of head injuries. As a result, helmets have become offensive weapons on the heads of powerful athletes and yet
non- have not provided sufficient protection for the wearer. Investigation
rent showed that 45.7 per cent of the 430 football fatalities between 1931 and 1946 were due to skull fractures or brain injuries. Players consider the base of the skull and the back of the neck as the most vulnerable and least protected part of the body. Some players believe that the present stiff plastic helmet (see Figure 41) was largely responsible for many head injuries, possibly because the helmet frequently is forcibly shoved back and down against the base of the skull.

Clark Shaughnessy, an outstanding football coach and winner of the National Safety Council citation in 1943 for his work in preventing accidents among football players, offers the following suggestions for selection and use of football helmets:

1. Helmets should always be comfortable. Players will discard tight ones entirely or will loosen straps. When the straps are loosened, helmets slip sideways, forward or backward when subjected to blows.
2. Inasmuch as size and shapes of heads vary considerably, a

helmet that can be adjusted to conform somewhat to variations in shapes of the head is desirable.
3. At no point should the head ever come in contact with the wall of the helmet. Any blow at any point on the outside of the helmet should be distributed over its entire surface.
4. Materials should be used that will withstand any possible blow without denting.
5. Old helmets that no longer protect should never be used.
6. Players should be taught to adjust and keep their own helmets properly fitted.[1]

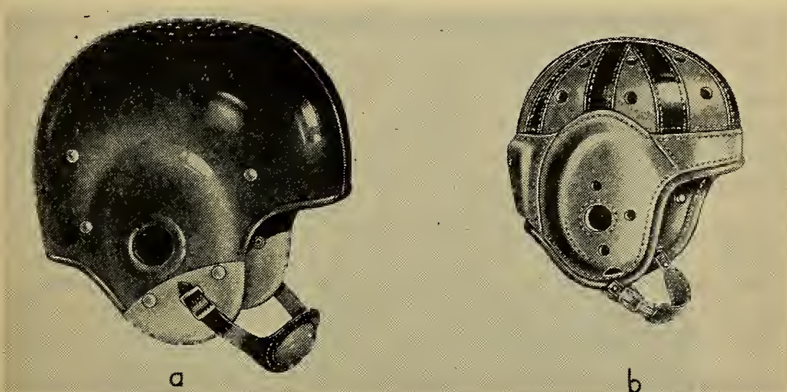

Figure 41. Football helmets: (a) plastic helmet, (b) helmet manufactured by sewing leather to a molded fiber crown-inside of helmet is padded with layer of sponge rubber. (*Courtesy of Rawlings Manufacturing Company.*)

See Figure 41 for a helmet in which a web hammock prevents head from coming in contact with top of helmet.

Mr. Shaughnessy and others have designed numerous helmets to meet the requirements and qualifications quoted above. Approximately thirty helmets, manufactured by various sporting goods companies were studied by Mock and his associates. The chief protective principle, common to all those helmets, was the hard shell, or exterior surface. On the inside of the shell they found various types of material (canvas, rubber, kapok and others) attached to the shell and made to conform to the contours of the head in an effort to hold the helmet snugly in place. The chief aim seemed to be to make the helmet comfortable but not cumbersome.

Much of the material used as interior padding was so thin that a

[1] Harry Mock, M.D., and others, "Head On," *Safety Education,* 28:10, January, 1948.

hard blow to the shell must result in bringing it in direct contact with the scalp and underlying skull. Instead of dispersing the force waves throughout the shell, this contact transmits force waves directly against the skull. Such a helmet may protect the skull against a fracture but it does not protect the brain.

In some helmets, just a light blow seems to give an impact of force to the base of the skull and to the back of the neck. Even when the material inside the hard exterior shell of the helmet is sufficiently thick to prevent direct contact with the skull, it is possible that the force waves in the shell are not directed toward the peripheral edge of the skull.

Dr. Mock suggests that a more careful study of head injuries is needed, and if, as suspected, the base of the skull with its great collection of blood vessels is a vulnerable area, then some better method of protecting the skull where it joins the spinal column is needed. He continues:

> Further research might reveal that the present hard plastic helmet is the activating force at this vulnerable spot or enhances the danger of injury by 'contrecoup'—the process whereby force waves are centered at the spot in the skull or brain opposite the site of the blow.[2]

Research thus far has indicated that the following features are needed for adequate protection: a leather or canvas foundation, similar to a hatband, and adjustable to the size of the individual's head; a snugly fitting chin strap; a strong occipital strap or hammock with a crisscross of canvas straps conforming to the contour of the head; all of this fastened to a plastic or fiber shell in such a manner so as at all times to prevent the shell from making any contact with the canvas webbing. A better cushion type of padding, such as sponge rubber up to one inch thick, would possibly further prevent direct contact with the skull and disperse the force waves to a great extent.

Helmets which have a canvas, leather or rubber padding, regardless of their thickness, attached directly to the fiber or plastic shell, furnish less protection to severe jarring than those with an air space between the foundation and the shell.

Since the exterior of the shell must be hard enough to prevent denting, it becomes an offensive menace to the player struck forcibly by this material. It is suggested that all shells be covered with a one inch thickness of sponge rubber or some equally resilient material.

Specially designed helmets are often used to prevent reinjury or

[2] *Ibid.*, 28:31, February, 1948.

further damage to an old injury. Such a helmet is shown in Figure 42. Other types are designed for protection of the nose.

Shoulder Pads

Shoulder pads are manufactured in two distinct types, cantilever pads and flat pads (see Figure 43), and in approximately two dozen styles. Coaches, trainers and players have long debated the merits of both the cantilever and the flat shoulder pad.

The cantilever pad, when constructed so that leather or web straps

Figure 42. Football helmet with extra protection to the jaw. (*Courtesy of Wilson Sporting Goods Company.*)

hold the body of the pad away from the shoulder, is not advisable, since in this case a very small area of the shoulder absorbs all of the shock from any sharp blow. The body of the pad should rest on the shoulder, thus distributing the blow over the chest and back area, and allowing very little to fall on the shoulders. Some coaches point out that flat pads are more comfortable than cantilever pads and present a better appearance.

Three kinds of materials are used as padding: foam rubber, kapok and quilted kapok. Pads lined with heavy foam rubber probably give the best protection for a short period of time, but foam rubber rapidly loses its resiliency when it has become soaked with perspira-

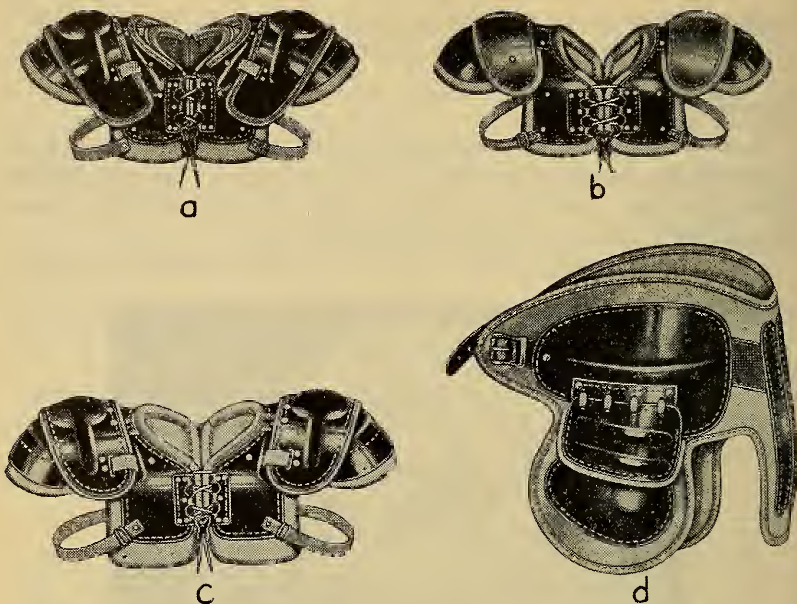

Figure 43. Shoulder and hip pads for football: (a) regular cantilever pad for backfield men; (b) a form-fitting flat pad for backfield men; (c) regular flat shoulder pad, heavier and usually used for linemen; (d) three-piece hip pad-molded, corrugated short-rib and kidney fibers with flexible leather hip protectors. (*Courtesy of Rawlings Manufacturing Company.*)

tion. Especially is this true if the same shoulder pads are used for practice and for games. Most manufacturers, in an effort to protect the foam rubber, cover it with airplane silk, drill cloth, or some other material. Most of these materials are moisture repellent but not moisture proof. Moisture-proof material will protect padding longer.

Stuffed kapok, not as resilient as rubber but less expensive and easier to recondition, is used on most medium priced shoulder pads. Perspiration often will cause it to become packed and smooth, thus losing much of its resiliency. Proper drying after each practice or game will lengthen the protective qualities of kapok.

Quilted kapok is pressed into layers—two or more thicknesses are sewn together and then fastened to the fiber shell. Quilted kapok padding has very little resiliency and is used most often on junior equipment. Layers of felt are also used.

Important to the comfort of the player is the type of binding used on the pad where it comes in contact with the player's neck. Sheep-

skin, because of its softness and pliability, is probably the best binding. Cowhide has a greater tensile strength, is not so soft and is less pliable. Both sheepskin and cowhide are superior to fabric or tape.

When selecting or checking an order of shoulder pads, examine for the following:

PAD. 1. Padding—kapok should not be matted or lumpy and should have adequate thickness; Prime Java kapok is best. If reclaimed kapok is used, it should be clean and sterilized. If foam rubber is used, it should have adequate thickness and resiliency and be covered with moisture-proof cloth or similar covering.

2. Fabric—no material defects or needle chews which might develop into holes or tears.

3. Seams and stitching—no more than three broken or skipped stitches on the fabric; no run-offs on binding; no fewer than three or more than five stitches per inch on the fiber; and the fineness of thread not less than 10/5 cord linen or cotton for fiber. For fabric, eight to twelve stitches per inch is satisfactory and the fineness of thread should be not less than 36/4 cord. (Variation in number of stitches per inch is permitted when due to speeding up machine or to pulling the material in order to sew over heavy seams or thick places on the shoulder pad, or in turning corners.)

FIBER PIECES. 1. Quality—not less than 9/100 inch thick and no cracks or holes.

2. Position—proper alignment with the padding is important.

3. Size—flaps approximately 10½ by 4¼ inches; cap approximately 8¼ by 4¾ inches.

LEATHER HINGES. 1. Width—not less than 2 inches wide and 1/16 inch thick.

2. Riveting to fiber—all fiber pieces securely clinched; no fewer than three rivets on flap and cap; and no fewer than two rivets on the arch.

BINDING ON FIBER. 1. Presence—absolutely essential for the area around the neck and important to have flaps bound.

2. Type—for the neck, sheepskin better than cowhide; both better than tape or cloth. For flaps, cowhide best; tape or cloth is a second choice.

EYELETS. Presence—not fewer than three on a side and the clinching must be secure.

ELASTIC STRAPS. Width—straps not less than one inch and securely riveted at each end.

LACES. Presence and length—front lace at least 54 inches long; back lace, not less than 42 inches and a slide fastener on each lace.[3]

Hip Pads

When selecting hip pads, the style to purchase depends to a great extent upon the type of block the players are going to use most frequently. For a crossbody block type of play, the hip pad must be high enough to protect the ribs of the players and heavy enough to protect the hip and kidney regions. If a shoulder block or brush block is used most often, the pad will not need this extra size and weight and therefore can be made lighter and more comfortable. A good hip pad has a strong piece, usually made of fiber or leather, to cover the coccyx area of the spine (see Figure 43). The fiber should form a cuplike mold over the hips and the pad should stay in position regardless of the stance assumed by the player or of any body movements during actual play. The best pads made will not provide adequate protection unless the players know how and where they should be worn. It is the responsibility of the coaches to teach correct wearing and then insist upon compliance. As for padding, the same reasoning for the use of foam rubber and kapok holds true for hip pads as it did for shoulder pads.

When selecting or inspecting hip pads examine for the following:

PADS. Requirements for padding, fabric, seams and stitching the same as for shoulder pads.

FIBER PIECES. 1. Quality—thickness of the hip guard and kidney guard not less than 8/100 inch and for the flap and spine guard not less than 7/100 inch. Look for cracks.

2. Position—fiber pieces sewed less than one inch from top of padding.

KIDNEY HINGES. Construction—made of leather and the rivets secure.

HIP FLAPS. Lacing—hip flaps laced securely to the kidney hinge; the lacing of leather.

BUCKLE AND STRAP. Construction—a buckle is better than D rings; the riveting should be secure, and the webbing should be not less than one inch wide and 1/16 inch thick. Zig-zag stitching or some

[3] United States Office of Quartermaster General, *Pads, Shoulder, Football,* May 25, 1945, pp. 5–8.

other method to prevent unraveling at the end of the strap should be used.[4]

Injury Pads

Injury pads can be made at the school or college. The most important principle to keep in mind is to radiate the shock away from the injury spot. This can be done for the most part by making pads out of pieces of fiber which are built up around the edges, leaving a hollow center to cover the injured spot. These pads can be applied to elbows, hips, shoulders, spine base and other spots. The trainer or team doctor should advise exactly what shape is desired. The fiber should be cut when wet and bent to the desired shape before building up edges with felt or sponge rubber.

Knee Pads

Knee pads present one of the most difficult problems for anyone selecting football equipment. To find a pad which will give the protection needed and yet allow for the fullest freedom of movement has been one of the goals of athletic goods manufacturers. (One coach uses a big, wide, bell-shaped knee pad of stuffed kapok fastened into the practice shells, and pads cut from ½ inch foam rubber for games.) Whatever knee pads might be purchased or improvised, they should be wide enough to cover the medial and lateral epicondyles of the tibia and high enough to protect the muscles between the area covered by the thigh guards and the knee cap.

Blocking Pads

Whether or not blocking pads are needed depends to a great extent upon the style of team play used. Players who execute shoulder blocks or brush blocks usually do not need blocking pads to cover the ribs. Guards or blocking backs who execute a great number of crossbody blocks should have them. Pads lined with foam rubber provide more protection, but kapok padding is slightly more durable. Blocking pads that are made as a separate unit with adjustable shoulder straps are usually preferred to those that are laced to the shoulder pads. With the former style there is no need to purchase specially constructed shoulder pads which may or may not be used each year.

[4] United States Office of Quartermaster General, *Pads, Hip*, June 1, 1945, pp. 3-6.

Ball

One erroneous conception entertained by many people is that a football is made of pigskin. Such a belief probably was started many years ago when the game of football was being developed and when an inflated pigskin bladder was used as a ball. Today many materials are used.

LEATHER. The majority of footballs are made of leather, usually of selected cowhide. After tanning the leather is cut into panels and the panels put through a skiving machine which shaves them to a predetermined thickness. Each panel is then weighed, graded as to quality, and the lining is attached. Usually this lining consists of three layers of tackle twill or some equally strong fabric, cemented together to prevent stretching and to produce uniformity. When the lining is in place the facing is applied to the areas that will carry the lacing holes and also the hole for the inflating needle. The holes are then punched and the four panels are sewn together by a hot wax lock-stitch machine. The ends of each ball are then sewn by hand and the ball is turned right side out. The bladder is next inserted and the ball is laced and inflated. After inflation it is checked for correct dimensions and circumferences.

The National Collegiate Football Rules specify the following for a football:

> The ball shall be made of pebble-grained leather (natural tanned color) without corrugation of any kind, enclosing a rubber bladder. It shall be inflated with a pressure of not less than 12½ pounds nor more than 13½ pounds and shall have the shape of a prolate spheroid—the entire surface to be convex.
>
> The circumference, long axis, shall measure not less than 28 inches, nor more than 28½ inches; the length of the long axis shall measure not less than 11 inches, nor more than 11¼ inches. The weight of the ball shall be from 14 ounces to 15 ounces.[5]

The leather for the cover should be chrome vegetable or combination tanned cowhide or steerhide (see Leathers, pages 299–304). Sheepskin is sometimes used for the least expensive balls. To a great extent the cost of a football is in line with the quality of leather used for the cover and the quality of rubber used for the bladder. The style of the bladder has some effect in that balls with a molded bladder are more expensive than the traditional one-piece bladder. Since all footballs have an embossed finish (stamped on by means of

[5] *Official Football Rules,* 1950, p. 13.

etched, engraved or electrotyped plates), it is difficult for the average person interested in purchasing footballs to discover the defects, if any, of the leather panels. To know thoroughly what type and quality football is being ordered, it is rather essential that one be torn apart in a carefully planned inspection. This type of analysis is recommended whenever any quantity of footballs is being purchased. Following is a list of suggestions that might be followed for a detailed inspection:

1. Leather—no holes, cuts, deep scratches, loose fiber, sponginess and broken grain. Thickness not less than 3/64 inch and finished side pebble grained, two-tone tan, aniline or pigmented finish. Finish should not crack, rub off, peel or flake off excessively when leather is bent upon itself grain-side out.
2. Lining—high grade bleached or unbleached herringbone twill or equal is preferable; not less than two plies; three is recommended and the bond between the laminations should be secure.
3. Lacing—color optional; thickness not less than 1/32 inch; width approximately 3/16 inch; breaking strength not less than 35 pounds when tested at room temperature.
4. Bladder—free of leaks or weaknesses for potential rupture or leakage, and the rubber valve must not leak air.
5. Stitching of lining to leather panels—a lock-stitch and the thread no finer than 20/4 cotton thread; stitching no less than 1/16 or more than 3/32 inch from the edge and smooth without wrinkles or puckers; no fewer than five nor more than eight stitches per inch is recommended.
6. Stitching together of leather panels—waxed linen thread ten ply or equivalent size cotton thread; and the stitching should be ⅛ inch to ¼ inch from edge; lock-stitched seams using five or six stitches per inch, lock-stitch adjusted so that lock is formed on *bottom side* of seam. This requirement is essential so that the weak point of the stitch (that is, the locking) will be removed from the point of the strain which is the center of the seam. There should be no high seams or rough and sharp edges and no broken or skipped stitches.
7. Size—circumference of the major axis 28 to 28½ inches; the minor axis, 20½ to 21½ inches; the length, 11 to 11½ inches; and the weight, 14 to 15 ounces.[6]

RUBBER COVERED. Under this heading, two types of balls are frequently listed—one correctly and one incorrectly. A rubber football

[6] United States Office of Quartermaster General, *Football,* August 23, 1946, pp. 2–8.

is one made usually by forming a single air retaining bladder or lining into the shape of a football. It has no bladder and no carcass or fabric laminations to give it firmness, and in its crudest form can be likened to a balloon with a spherical shape. That is *not* the type referred to by the descriptive phrase rubber-covered football. A rubber-covered football is similar in many ways to a leather football. It has a bladder, a carcass or foundation made of two to five layers of fabric, or in some cases made of many layers of cemented cord. Over the bladder and carcass is molded a rubber cover.

The controversy of leather versus rubber-covered footballs has grown during the last few years until all of the large athletic equipment manufacturers now are manufacturing and selling both lines, leather and rubber covered.

According to those who favor the rubber-covered ball, rubber can be compounded in such a way that an expert who has been blindfolded cannot tell the difference between it and leather. They further state that, since the rubber-covered ball is lined with fabric and is vulcanized so that its various layers of bladder, fabric and cover form a cohesive unit, a rubber-covered ball will retain its shape better than a leather ball. The cost also is a vital point, for on the whole the initial investment in a rubber-covered football is somewhere between one-third and one-half as much as a top-line leather one. All of these factors—low cost, longer wear, longer official performance, according to those who have used rubber-covered balls—represent more value per dollar than in any other type of ball. This economy factor has been especially important for small schools, both urban and rural, recreation clubs and city playgrounds.

In selecting a good quality of rubber-covered football, consideration should first be given to its construction. A Quartermaster Corps specification suggests the following:

> The ball shall consist of a rubber bladder or air-retaining lining, a plied fabric carcass or a cord-wound carcass (or a combination of these two) and a rubber cover vulcanized integrally with the carcass. The ball shall have a leak-proof rubber type valve for inflation.
>
> The bladder or lining shall be substantially uniform in thickness and suitably air-retaining. The cover shall be boned to the carcass so that it completely covers the carcass, leaving no exposed textile material, and shall be substantially uniform in thickness except at the stimulated seams and lacing.
>
> The carcass shall be made of cotton or rayon fabric or wound cotton or rayon cord. The layers of fabric shall be securely

bonded together or if cord is used, the carcass shall be coated with rubber latex or cement.

The finished rubber-covered ball shall simulate the appearance of the official leather-covered football and shall have simulated seams of conventional pattern molded into the surface. In molding, the two halves shall be aligned evenly, and the flash line shall be neatly trimmed.

The finished footballs should conform to the following requirements:

Circumference of major axis	—27½	to 28½	inches.
Circumference of minor axis	—20½	to 21½	inches.
Length	—11	to 11¾	inches.
Weight	—14	to 15	ounces.[7]

The quality of the rubber used for the bladder and the cover is at the discretion of the manufacturer, and it is difficult for the layman to differentiate between qualities without the aid of chemical tests. Natural rubber (no synthetics) provides the best air retention and service. (See pages 269–270) for additional information on rubber-covered balls).

Along with durability, another important item which has drawn many comments from high school and college athletes is the matter of feel. Feel comprises not only the surface texture and the pebbled grain surface of the ball, but also the resiliency of the carcass and body of the football when it is handled, passed or kicked. Manufacturers of rubber-covered footballs have been quite successful in producing balls that simulate leather balls in appearance, and they are constantly experimenting with methods to improve the feel.

Another important factor in the selection of a football is its adherence to official standards. At the present time, the official football rules (and those of most other sports) specify that a leather ball shall be used. However, during recent years, officialdom has not adopted, but has sanctioned use of rubber-covered balls under certain conditions. For example, the state of Oregon is using a rubber-covered football on a wet field because they believe that it handles better, passes more easily and does not become soggy or absorb water. It also eliminates the need for replacing the ball every few plays.

COATED FABRIC. A third type of ball is the coated-fabric football. Unlike the leather-covered and the rubber-covered ball, this one is

[7] United States Office of Quartermaster General, *Football, Rubber-Covered,* February 14, 1946, pp. 2–3.

not yet available on the market. Little is known about the ball, but those who have been working on and conducting experiments with the coated-fabric ball are high in their praise of it. Many believe that this type of ball is superior in most ways, including durability, cost, and performance, to either the leather- or the rubber-covered football. Construction methods of this new football are similar to the leather ball; its main difference is the material of the cover, usually plasticized vinyl resin or polyvinyl butyrol.

Uniform

The rugged, body contact type of activity which characterizes football requires that primary consideration be given to the safety of the player. This in turn has necessitated the use of protective gear, worn on various parts of the body, to minimize the effect of severe body contacts, plus contact with the ground. Over these paddings a comfortable, durable uniform is worn. Any consideration of clothing for football must, therefore, be based on the need for fabrics that are durable and flexible, and for styling that permits great freedom of action, in spite of the equipment over which the garments are worn. Adequate size is also an important factor, as is lightness of fabric, since the player is already burdened with the extra load of padding.

The varied weather conditions under which the game is played call for fabrics that are resistant to dirt and mud, and at the same time have excellent moisture absorbency for the absorption of perspiration. Garments should also be highly resistant to abrasion. Fabric weight and type must be varied to suit the climate in which the game is played. A slick surface is desired so that tacklers will find it difficult to secure a firm hold on the garment. Finally, it should be possible for all garments to be easily cleaned, preferably washed, and consequently they should be colorfast to repeated cleanings. Colorfastness to sunlight is another important property. Football is one sport in which all properties of fabrics and garments are highly essential because of the many demands made on the garment by the game itself. Figure 44 illustrates one style of football uniform.

JERSEY. Jerseys are made in four major styles—plain, supporter style, raglan sleeve, elastic shoulder insert. Each of these styles may include features contained in the other types. The plain style is a standard shirt type jersey with set in sleeves and without extra styling features, such as shoulder inserts, supporter attachment and other special items. The supporter jersey is similar in design to the plain style but has a supporter attachment that buttons on to the

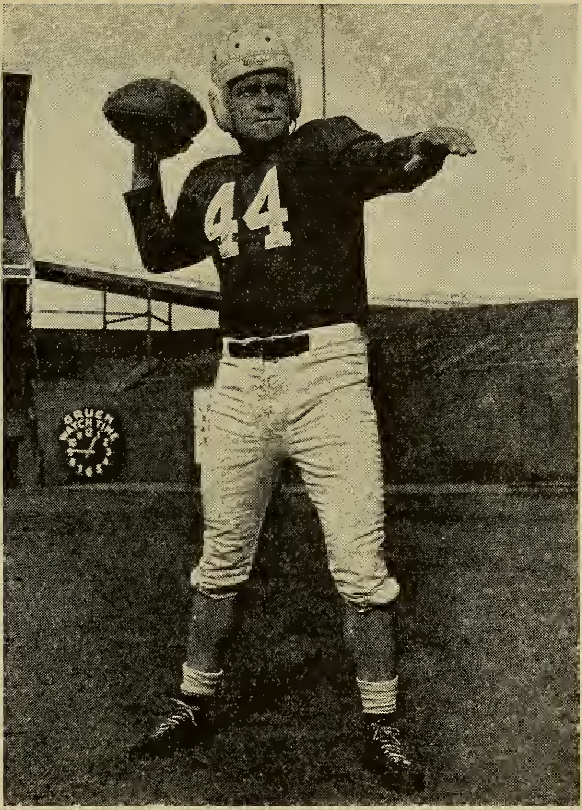

Figure 44. Football uniform. (*Courtesy of Wilson Sporting Goods Company.*)

jersey. This styling holds the pads in place and keeps the shirt from slipping out of the pants. Raglan sleeves are the distinctive feature of the raglan jersey. The design of these sleeves permits the shoulder and sleeve of the jersey to fit comfortably and without undue strain over the shoulder pads. In the fourth style jersey, elastic knit inserts on the shoulder (and sometimes down the sleeves) serve this same purpose of comfortable fit and ease of action.

Regardless of specific style, all jerseys have round, collarless necklines and long sleeves. The neckline should be cut low enough to prevent binding. Good length is needed to keep the jersey under the pants during action. Underarm gussets are featured in some jerseys. This type construction allows greater freedom of arm action and

there is less tendency for the shirt to pull out of the pants. Sleeves should be full length.

Wool or worsted jerseys provide both comfort and fit. The moisture absorption and quick evaporation properties of wool are excellent. Cotton is used as reinforcement of wool, rayon and nylon fabrics. Rayon is smooth and lustrous. Nylon jerseys have excellent wearing qualities. Cotton jerseys are used mainly for practice sessions. A heavyweight cotton is desirable. Jerseys may be a solid color or have a contrasting color shoulder and sleeve insert. Light colors show dirt and soil quickly.

The Quartermaster Corps, in a specification for football uniforms, lists the following detail requirements:

> The Jersey shall be regulation football type, round neck with long sleeves and inside elbow reinforcement pieces. The neck opening shall be finished with a double thickness, seamless, one inch collarette, . . . attached with the ribs running at right angles to the seam. The shoulders may be conventional type or yoke type with set in sleeves or raglan type sleeves. The shoulder area must be double thickness fabric to provide reinforcement.
>
> Elbows shall have a reinforcing patch, approximately 6x9 inches, attached to the inside with a 3 to 4 inch opening on the upper side to permit insertion of an elbow pad. Reinforcement piece shall be attached with a covering stitch. The bottom of the jersey shall be made with a split tail with 5 to 6 inch openings at side seams. Side openings, bottom and bottom of sleeves shall be hemmed with a covering stitch. Front and back of the jersey shall have wool felt numerals, plain block type letters measuring 8 inches in height for the back and 6 inches in height for the front. The numerals shall be white or contrasting colors, commercially vat dyed. Numerals shall be securely stitched on the jersey with the number either single or double digits, providing range of numbers through each set of uniforms. Jersey shall have a size label; commercial trade labels may be used. The shoulder, armhole, neck, sleeves and side seams shall be seamed and covering seamed with 2 operations.[8]

Commercial jerseys are usually sold in size classifications of small (34–36), medium (38–40), large (42–44). These sizes represent chest measurements. The Quartermaster Corps lists more detailed measurements for jerseys, including fabric, weight and garment size, as indicated in Table 11.

[8] United States Office of Quartermaster General, *Uniform, Football,* October 2, 1945, p. 4.

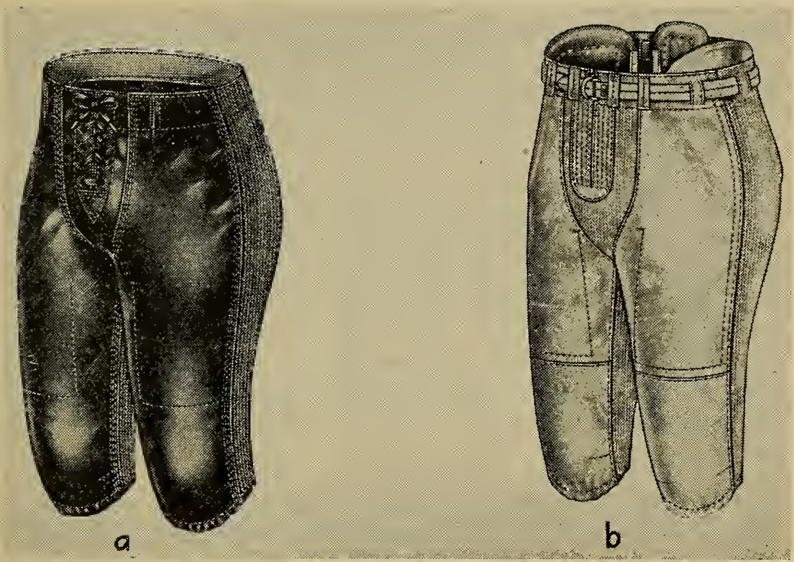

Figure 45. Football pants: (a) half and half football shell with self material front panels and knit back; (b) one-piece game pants with built-in three-piece hip pad attached to the pants by an interlacing belt, a crotch insert and a slide fastener front. (*Courtesy of Rawlings Manufacturing Company.*)

Table 11

SIZE CHART FOR FOOTBALL JERSEYS[9]

Size	*34*	*36*	*38*	*40*	*42*	*44*	*46*
Width Chest	16	17	18	19	20	21	22
Width Bottom	15	16	16	17	18	19	20
Length	29	30	30	31	31	32	32
Armhole Length	10	10½	10½	10½	11	11	11½
Sleeve Length (underarm)	21	21	21	22	22	23	23
Elbow Width	6	6	6	6	6½	6½	6½
Cuff Width	4	4	4	4	4½	4½	4½
Weight per Dozen lbs. minimum	9	10	11	12	13	14	15

PANTS. One-piece pants are complete, with all necessary padding. Shell pants, as the name implies, are empty of the protective padding, although pockets are provided for the insertion of padding at each area where additional protection is needed (see Figure 45). The padding is purchased separately and then inserted in these spaces.

[9] *Ibid.*

Most shells are supplied with loose hanging knee pads. Some coaches advise the purchase of shell pants rather than the one-piece style because pads can be purchased separately, and when worn out can be discarded without the need for high replacement cost. However, the one-piece type of pants is easier to care for and may, for this reason, be preferable.

Nylon now has become an important fabric for use in football pants. Initial cost of these pants is high, but their excellent wearing qualities make them a long-run economy. If a school can afford the initial outlay, they are well worth considering. In very warm climates nylon may not be as satisfactory, since it is low in moisture absorbency.

The Quartermaster Corps specified that the fabric should be evenly dyed and should show fastness to laundering and weather. In addition, the following detail requirements for football pants are listed:

> *Pants*—Shall be shell type equipped with knee pads and thigh guards and have a grown-on waistband. Waistband lining and thigh guard pockets shall be a good commercial grade of drill. Pants shall be fitted with tunnel loops and regular front belt loops at waist with an opening to provide for a 2 inch belt. Outseams, inseams, seat seams, crotch piece and crotch seams shall be *double lapped and double or triple stitched.* There shall be a fly opening in front, approximately 8 inches, reinforced with webbing or tape and have not less than 6 metal or stitched eyelets on each side, equally spaced. A curtain of self material, approximately 9″ x 3″ shall be caught to right side of fly, turned over and securely box stitched at fly base. Pants shall be securely reinforced with a triangular leather piece at fly base and on the inside. Crotch piece shall be single or double ply and have not less than 3 stitched eyelets for ventilation. The fronts of pants shall be reinforced with self crotch or a good commercial drill extending over knees on the inside from bottom up, approximately 10 inches. Fronts shall have drill thigh pockets stitched on the inside approximately 12″ x 9½″ and positioned about 8 inches below top of waistband. Front leg bottoms shall have 2 inch darts at side seams and back parts shall have about a 14 inch dart on each leg from bottoms up. All leg bottoms shall be cut-back, and hemmed with a ⅝ inch elastic, inserted in front hems in such manner as to taper leg-bottoms. There shall be a pad stitched on the inside at each knee positioned so that knee pads shall extend 2 inches on thigh pockets and 1½ inches below leg bottoms. Each pants shall have a lace fitted into eyelets at fly opening. A size marking shall be placed in pants . . .[10]

[10] *Ibid.*, p. 5.

Construction that permits snug fit and flexible stretch is ideal. Some pants feature the use of an elastic knit, two-way stretch weave in the back of the pants. Darts may also be used in this section of the pants for better fit. Knees and crotch are subjected to a great deal of strain. Both areas may be reinforced, and some pants have elastic knit ventilated gussets at the crotch. For fullness at the knees, pleats may be used. Laces or slide fasteners are used on the front closeups.

Pants are sized according to waist and hip measurement. Both are important. In some style pants the length of leg varies. Pants may be obtained in regular, long and short leg lengths. This measurement is based on the length of the inseam. Quartermaster specifications require that pants shall conform to the minimum measurements listed in Table 12. Quartermaster specifications also stipulate that the thread should be a good quality, fast in color, and eight stitches to the inch.

Table 12

SIZE CHART FOR FOOTBALL PANTS[11]

Size	*Actual Waist Measure*	*Seat Measure 8″ down from Top of Waistband*	*Inseam*	*Outseam from Top of Waistband*	*Front Rise from Top of Waistband*	*Back Rise from Top of Waistband*
30	32″	46″	21″	31¾″	14″	18½″
32	34″	48″	21″	32″	14¼″	18¾″
34	36″	50″	21″	32¼″	14½″	19″
36	38″	52″	21″	32½″	14¾″	19¼″
38	40″	54″	21″	32¾″	15″	19½″

Recently, for spring practice and hot weather scrimmages, a shortened version of the usual football costume has been tried out in some of the southern states. Short sleeved shirts are worn *under* the shoulder pads; pants are short and extend just below the thigh guard pocket. A separate knee pad fits up against the bottom of the thigh guard.

Pockets for protective padding in pants should be placed a little to the side of the thigh, and the knee pad pocket should extend to and preferably slightly beyond the thigh pocket, so that there is less chance of injury in this area than would be possible if pads did not overlap slightly, thus leaving an unprotected area.

The cost of uniforms depends on the following factors: (1) quality

[11] United States Office of Quartermaster General, *Uniform, Football,* op. cit., p. 6.

and type of fabric; (2) cut; (3) standard or custom make; and, (4) trimming. There is an extra charge for jerseys that have elastic shoulder inserts, raglan shoulders, elbow pads, and supporter attachments, as well as for those that are extra long. In pants, the one-piece style is more expensive than the shell variety. Additional features in pants such as ventilated crotch, two-way stretch, slide fastener closing and other similar features add to the cost. Junior model pants are less expensive than the regulation size pants. It is well to have two to three sets of uniforms for each player so that more frequent cleaning is possible.

WARM-UP SUIT, JACKET. The same type of warm-up suits and jackets are worn for football as are used for regular gymnasium costume, with the exception that jackets of suits, or separate jackets, may have hoods that can be worn over the head in cold weather. This style is excellent for wear during cold or rainy weather (see Gymnasium Costume, pages 294–295).

HOSE. The same type of hose is worn for football as is used in baseball. Knee-length athletic hose, footless but with a white stirrup, are worn over white socks. For detailed information concerning hose, see Baseball Uniforms, pages 50–51.

SHOES. When selecting football shoes, a soft-toe shoe is usually considered to be more comfortable than a hard-toe shoe. The latter, however, provides more protection for the toes and presents a better kicking area for the place-kicking specialist. A kicking toe may be worn with either type of shoe.

Materials. The type of leather used for the shoe depends to a great extent on the budget. Because the fiber of the skin is interwoven instead of being in layers, shoes made of kangaroo are light, strong and quite durable. Weight for weight, kangaroo is the strongest of all shoe leathers. Whether it is blue-back or yellow-back kangaroo does not make too much difference. Lower priced shoes are usually made from selected calfskin or cowhide. Methods of tanning differ, but an oil-base tanning process used on cowhide often produces a leather that is more water resistant and scuff resistant than hides tanned by the ordinary process. Shoes with cowhide uppers may be advertised as being made of athletic leather, Sportan or some other trade-name (see Leathers, pages 299–304).

Cleats. When selecting cleats, if the budget will allow only one type, get those made of soft rubber since they are more comfortable,

will not chip and will wear longer. If it is possible to purchase two or three sets, govern selection by the nature of the fields on which the games are played. On hard ground, use a soft rubber cleat, and vice versa. Use mud cleats only for heavy mud or deep snow. A special rubber-cleated canvas-top shoe is suggested for playing on ice. For protective reasons, "male" cleats are essential. (Male cleats screw into the sole; female cleats screw onto a metal post permanently mounted on the sole). Some type of locking device to prevent the cleat from backing off is highly recommended. Many injuries such as lacerations and deep skin punctures are caused each year by exposed steel cleat posts after the female cleat has been lost during practice or a game.

Construction. Whether the shoes should have a split-shank (two-piece) or a straight shank sole is a matter of personal opinion. Some manufacturers and coaches report that the single-piece construction is more durable but not quite so flexible. Advocates of the two-piece construction say that it is far more flexible and when properly constructed, equal to the straight shank in durability.

The shoe section of nearly every athletic equipment catalogue contains one or all of these terms when describing shoe construction: Goodyear Welt, Turned Shoe, and Littleway Stitch. In selecting football shoes, it is important to know which method of construction best fits the needs of each purchaser and what one is getting when any of the three have been chosen.

Goodyear Welt Construction—Nearly all the top grade shoes and some of the medium priced shoes are constructed with the genuine Goodyear Welt. Goodyear Welt construction is unique in the formation of the two seams used and their unsurpassable positions of advantage in the shoe bottom. There is a hidden seam of sewing, holding together the welt, the upper, the lining and the insole, and showing an almost horizontal position in cross section. With this seam, which is the primary attachment of the shoe bottom, there is no direct penetration of the insole, although it goes squarely through the upper and the linings contained therein. The stitching is a chain-stitch seam and lies on the side of the insole opposite to that which touches the foot of the wearer. The inside of the shoe is therefore clear of all thread. The outsole is attached by means of a lock-stitch seam that passes through the flattened welt and the edge of the outsole. Thus the seam or stitching is outside the area of greatest pressure in wear since it does not come immediately under the sole of the foot. This, in actual practice, means that the seam does not meet the

same degree of wear abrasion as other areas in the center of the outsole. If the shoe is made with a composition or rubber sole and in some cases, with a leather sole, the sole attaching seam is stitched aloft, in which case the stitches show on the finished shoe bottom. Both seams, the inseam and the outseam, are formed of strong threads of slightly different types, and these are waxed when the stitches are made. The wax solidifies very rapidly after sewing, thus locking the tension strength of the thread.

If there are any doubts as to whether or not a shoe is constructed by the Goodyear Welt method, look under the insole. In the genuine Goodyear Welt shoe, there is no thread or stitching showing. Goodyear construction, Goodyear stitch and Goodyear built, or any other such combination, are not genuine Goodyear Welt constructed shoes.

Turned Shoe Construction—This method of shoemaking takes its name from the unique fact that the shoe is first made wrong side out and later in the manufacturing process turned right side out. The turned shoe is strictly a single-sole shoe, and primarily for this reason has a reputation for great flexibility, light weight and comfort. Only the lightest of football shoes (usually professional models) are made by this method, but because of their lightness, most of the top quality track shoes are turned shoes. They are light, flexible and very comfortable, but because of the single-sole, they are far surpassed by Goodyear Welt for durability. In the selection of soles, fine and semifine grain grades of leather are used. They must be soft and pliable when the shoes are lasted (the operation by means of which the shoe upper and lining are drawn down tightly to the wooden last over which the shoe is formed) so as to prevent cracking the grain of the leather in the process of turning. After the lasting operation is completed, the upper and the lining are stitched tightly to the sole while the shoe is in a wrong-side-out position on the last. The thread is thoroughly impregnated with wax to ensure a durable stitch. Because so many of the operations cannot be done satisfactorily by machine, the turned shoe, to a greater degree than in any other modern type of footwear, is handmade. As a last operation in the construction, a sock lining is inserted to cover the stitches and give the inside of the shoe a smooth, comfortable surface.

Littleway Stitch Construction—The unique feature of the Littleway Stitch process is its use of staples in lasting the shoe. These staples are made of fine wire and are used in such a way that the points reverse their direction within the thickness of the insole and do not penetrate to the foot surface. A lock-stitch seam is located out-

side the staples, and the tension of the thread is sufficient to sink the stitches slightly below the surface of the insole, thus providing a smooth surface on the inside of the shoe. The Littleway shoe is more durable but not as flexible and pliable as the turned shoe; neither is it as durable as the Goodyear Welt shoe.

Care and Repair[12]

Football equipment requires constant care and immediate repair if the items are to last several seasons. Schools and colleges often have a football manager whose main duty is to look after the equipment before and after scrimmages and games and to check on and store the equipment at the end of the season.

Helmet

Be sure, when storing helmets, that forms are used in the helmets and that the storeroom is perfectly dry. Never hang a helmet by the chin strap or ear piece, but use a rod or dowel as explained on page 138. If space permits, set up helmets resting on the back piece and two ear pieces. Never place helmets in a duffle bag. Caution players not to throw helmets to the ground or into a locker. Sitting on a helmet will crush the fiber parts. More abuse is given a helmet out of actual play than in a game.

In checking helmets for wear, examine chin straps and make sure they can be fastened. Replace worn straps and missing snap fasteners. If a section of the cantilever sling has pulled away from the side of the crown, have it restitched at once if the webbing is not frayed. Use a new web strap if necessary, and try to catch stitches in the same fiber crown holes. The more holes in a piece of fiber, the weaker it becomes. If the crown becomes dented, straighten by dampening the dented area and pounding it out from the inside. Broken crowns should be replaced by a qualified athletic equipment renovator.

LEATHER. All players must wear head protectors which must constantly be kept in excellent condition to insure maximum protection to the wearer.

Cleaning. Remove mud and other field substances from the outside and inside with a stiff brush. A damp cloth may be employed also, but care should be taken that the leather remains fairly dry.

12 Much of the information on the following pages has been taken from The Naval Institute, *Intramural Program,* 1950.

Drying. Always dry wet helmets at room temperature. Use helmet forms or trees. Crushed newspaper will aid the drying action in the same manner it does in shoes. If neither trees nor forms are available, hang helmets from a rod or dowel passed through the large ear holes. The rod should be long enough to accommodate twelve helmets. If longer, it will be unwieldy and cumbersome. Shape the helmet with the hands and press out any excessive moisture from the padding. Never force helmets into a trunk nor allow wet helmets to remain in a trunk longer than is absolutely necessary.

Dressing. After the mud and dirt have been removed and the leather helmet is perfectly dry, paint a thin coat of clear leather lacquer over the outside area to aid in preserving the leather and give the helmet a glossy appearance. The lacquer will prevent moisture from penetrating the outside surface and reaching the fiber crown that is the heart of the helmet. If the lining is stiff, brush the inside of the helmet and apply a thin coat of oil or dubbing. Care should be taken not to soak this lining. If helmets are to be painted use only helmet enamel. The paint should be thin, since thick coats add excessive weight. Remove the clear lacquer with lacquer remover and be sure that the helmet is absolutely dry before painting. After the paint is dry, apply clear leather lacquer.

PLASTIC. *Cleaning.* Remove mud and other field substances from the outside with a damp or wet cloth, from the inside with a stiff brush.

Drying. Allow padding to dry at room temperature, using methods of suspension suggested for leather helmets.

Dressing. After the plastic has been cleaned of mud and dirt, paint a thin coat of clear lacquer over the outside area to renew the glossy appearance. If the helmet is to be painted, first remove all lacquer with a lacquer remover.

Shoulder and Hip Pads

The protective pieces of equipment must be checked for cleanliness and wear. Following are some suggestions:

CLEANING. Wash kapok padding with a mild soap and warm water. A scrub brush will aid in getting mud stains from the skirt. Rubber padding should be washed in the same manner, but when washing old or worn pads, be careful not to use too much water since rubber often absorbs more than kapok. Fiber and leather parts may

also be washed. Several rinsings will remove all traces of soap. Press surplus water from the padding. Dry shoulder pads and hip pads by hanging over a line or on wooden pegs fastened to a wall. Pads should be hung inside out when drying. Shape the fiber parts while drying and keep wet pads away from metal hooks.

DRESSING. Water and soap will usually remove the finish from fiber parts and the oil from leather parts. As soon as these parts are dry, coat fiber with a clear lacquer, and oil leather with a light leather dressing. Inspect for minor damages and worn parts. If any are found, have them repaired or replaced immediately.

GENERAL. Never hang shoulder pads by the elastic straps or laces. Store such harness resting on fiber parts with padding up, exposed to air. Pads may be "nested", but care should be taken that they are dry and clean. Major operations such as replacing a broken cantilever, epaulets, and shoulder caps should be left to a qualified renovator. However, a few stitches can be replaced locally and often prevent major breaks. When sending broken shoulder pads away for repair, send only the section with the part broken. Some coaches suggest combining unbroken parts to make another usable pad. Undamaged parts of worn-out hip and shoulder pads can be used as repair parts for other pads.

Ball

For information on care and repair of the various types of balls, see pages 268–270.

Uniform

The following suggestions for care and repair are those used by the United States Navy during World War II.

JERSEY.

> . . . Measurements of jerseys (wool) should be taken from the collar hem to the bottom of the skirt and from the armpit to bottom of the sleeve. Unusually dirty wool garments should be washed instead of dry cleaned. . . . Wash them by hand using a mild soap . . . The water should be pure and around 90° in temperature. A brush of medium bristle may be employed to stroke the dirt from the material. It is best to place the garment on a smooth flat surface while scrubbing. Letters, numerals, insignia, and other trimmings must be scrubbed carefully. Stroke with the grain of satin materials, in order not to scuff or break the fibers . . . Rinse several times in clear water of the same

temperature (90°) . . . Press out water by hand . . . dry in normal room temperature. Stretch and shape garments to normal size while drying and pressing. Jerseys should be stored in dust free boxes. Use moth flakes on wool and sprinkle some between the folds. Keep boxes out of damp rooms.[13]

PANTS.

Measurements of these items should also be noted before washing. It is important to know outseam measurements as well as waist sizes. If any shrinkage occurs, correct sizes may be obtained by manipulating the cloth while damp and during pressing . . . Place pants in tumbler with all attachments such as thigh guards, detachable pads, laces, belts, etc., removed. Lukewarm water and a mild soap solution should be used in the tumbler. Wash for fifteen minutes and rinse contents several times in clean water of same temperature . . . Place garments in an extractor, and after removing them, turn inside out and hangs by legs to dry completely. If knee pads are attached, press out excess water by hand and form to correct shape. Make certain that attached hip pads are shaped correctly and have plenty of air circulating through them while drying. Wet fibre can be bent to shape very easily. The drying should be done at room temperature. Do not use hot air dryers as found in most laundries. As soon as wearing apparel is dry, it should be inspected to see if any seams are broken, any holes have developed, or any fibre parts cracked. Immediate repair should then be made. If players are covered with mud, no harm will be done if they enter the shower room, without shoes, and wash off the excess dirt. Helmets, hip pads, shoulder pads, etc., are already wet and clean water will not hurt these pieces of equipment as long as the temperature is neither too hot nor too cold.[14]

If uniforms cannot be cleaned after each practice, allow any mud that is in the garments to dry out, then brush off the uniforms before storing them.

SHOES. For information on care and repair of shoes, see pages 264–267.

[13] *Ibid.*, p. 44.
[14] *Ibid.*, pp. 46–47.

CHAPTER IX

Golf

The origin of the game of golf is still a controversial issue among thousands of golf enthusiasts. Some authorities state that golf originated in Scotland, where Scottish shepherd boys knocked small stones into crude holes in the ground with a crook while their flocks grazed nearby. Another version is that the sport goes back to still earlier days in Holland where it was played on ice; still others identify it with another game played centuries ago in France. At any rate, it was played in Scotland in the fifteenth century and as far back as 1457 Parliament passed a law forbidding the game because it detracted from interest in archery. At that time wars were won or lost with the bow and arrow, and to hit a bull's-eye was more important than a well-placed iron shot.

Details of the introduction of golf to the United States are scanty and jumbled. The early city records of what now is Albany, New York, indicate that golf was played in that area as early as 1659 and that the town council banned the playing of the game in the streets because too many windows were being broken. On April 21, 1779, the *Rivington Gazette,* published in New York, informed its readers that they might secure first-class clubs and balls from the printer. Coming to more recent times, it seems quite certain that the St. Andrews Golf Club, located at Yonkers, New York, can be listed as the oldest golf club in the United States still in existence. It dates back to 1888. Others were formed earlier, but none survived.

Prior to 1848 the golf ball was made with a thick leather cover packed with steamed feathers to make a hard, heavy mass. In that year a new substance was found and balls made of gutta percha, molded while warm and painted white, were used. A second change occurred about 1899 when the rubber corked ball was invented in this country. The new and improved ball consisted of a center or core tightly wound with a fine rubber thread and covered with a vulcanizing material. Just as the gutta percha ball enabled the player to hit balls a greater distance than was possible with the mass of feathers, so this new patent added still more distance. The result was longer holes and lower scores. This same type of ball with modern improvements is one of many in use today.

Many questions have been asked about the reason for dimples on a golf ball, the questioners wondering if, in this modern era of streamlining, a smooth ball would not go much farther and straighter than the present dimpled ball. Recently a golf ball manufacturing firm was approached with the idea, and in order to present scientific data on the flight of golf balls, made elaborate tests with six each of three types of balls, all manufactured to the same specifications except cover design. One was the smooth ball; another, a ball in which half the surface was smooth and half was dimpled; and the third, the present all-dimpled ball. In tests made with a driving machine, the smooth ball left the tee in a normal manner and followed the usual upward trajectory for 10 yards, leveled off for another 10 and then took an abrupt nose dive. Including the roll, the total distance was 50 yards. All six tests had similar results. The second test with the half-smooth and half-dimpled ball was quite similar, and the average total distance was just a little over 100 yards. The ball hooked or sliced sharply, depending on which side the dimpled surface was placed. Using the same driving machine and six all-dimpled balls, the average distance was 230 yards.

The astonishing performance of the smooth ball can be explained by elementary aerodynamics. When the head of a golf club comes in contact with the ball it causes two actions: first, the ball spins, and second, it moves away from the club head. As the smooth ball travels through the air it causes air eddies to swirl around behind it and these eddies have suction-like qualities. Finally, a force builds up and becomes so strong as to check the forward motion of the ball, which drops to the ground because of gravity. The spinning action of the dimpled ball or any ball with a rough surface tends to break up the negative pressures exerted by the air eddies and the ball is permitted to go farther.

A properly hit golf ball has a backward spin of 4000 to 7000 revo-

lutions per minute, depending upon the type of club used. Speed photography has shown that though the face of a club and the ball are in contact for only 2/5000 of a second, yet in that time the ball attains an average speed of 150 miles per hour (wood clubs).

Whether they realized the reasons for it or not, golfers have always been concerned with principles of aerodynamics. The feather-stuffed ball used in the nineteenth century was made with a leather covering stitched like a baseball. The stitching made the ball sufficiently rough, and it performed exceedingly well, top golfers of the day being able to get 175 yards on their drives. After the introduction of the gutta percha ball, golfers discovered that a ball played better after it had been nicked and received small cuts from play. Players then began to nick and cut new balls before they were played, and this led to the introduction of the first dimpled ball in 1900.

Some of the wildest ideas concerning golf balls came from Englishmen. On August 25, 1903, one W. M. Short was granted a patent on a golf ball containing a small tubular ring to hold little free-rolling steel balls. Five years later the Kinzett brothers of Kensington were granted a patent for a golf ball with a core of "coagulated human blood, small birds' eggs, soap or Irish moss." Other balls have been made with centers of microbes, coiled springs, copper, and glass pellets. Several devices for locating a lost ball also were patented. One inventor embedded brilliant-colored spangles in the dimples; another designed a ball with a small cavity for a squid from which smoke was emitted. A third inserted a core which wound up while the ball was in flight and caused a bell to ring when it came to rest. Many inventors have concerned themselves with the surface of golf balls, and at least forty-four different designs, ranging from the usual dimple to an airplane, have been tried.

Equipment

Ball	Bag
Clubs	Club head covers
woods	Instruction aids (group)
irons	Costume

Ball

A group of scientists interested in testing consumer items discovered that, contrary to publicity claims, the primary cause for the score posted by any golfer was the factor of skill and ability, and not to any significant extent the amount that he paid for his golf balls.

There are probably many who select a golf ball on the basis of click, putting feel, controlled flight or some equally intangible factor

which advertisers would have golfers believe can be obtained proportionately to the greater amount one pays for a ball. Particularly is this true if one buys A's ball in preference to one manufactured by B or C. Many players choose balls in order to obtain "rotoactive flywheel action," a "talented golf ball," the "sweetest ball that ever clicked off the head of a golf club," or perhaps only the autographs of a highly paid professional. There is much pseudo-science in the advertising of golf balls and golf clubs, and many of the brands sold are camouflaged behind it. As a rule, advertising writers presenting copy to sell the public reserve the most elaborate phrases for the most expensive ball. This often leads readers to believe that the best score can come only from the expensive ball. For others, "there is a ball outstanding in its price range."

The construction of golf balls is rather simple (see Figure 46). The centers are usually made from a solid, liquid, or paste. The liquid may be honey or some substance peculiar to the manufacturer. Paste and liquid centers have the advantage of providing the means by which the windings can be put on under a higher tension, thus producing a livelier ball. This is usually done by freezing the center and winding rubber thread around the frozen core to a tension determined by the strength of the thread. Later, when the center thaws, the tension is increased by the expansion taking place as the core changes from the frozen to the liquid state, making the ball somewhat harder and more elastic in the zones near the core. Sometimes extra internal pressure and tightness are provided by putting dry ice into the ball as it is made. The resulting carbon dioxide forces the expansion.

Controversy over the best type of golf ball center is a continuous one. However, indications are that the liquid center, if manufactured so as not to leak under normal impact, will give a slightly truer flight because of the mobile mass which can flow or adjust itself while in flight. The hard rubber center has no chance to leak and must be considered more durable. Recently a new type of center has come to the front, one made of silicon. Laboratory tests have proven very satisfactory, but not enough actual service results are available for comparison.

The best cover is one that is thin and tough, characteristics which to some extent are mutually opposed. In tests conducted by *Consumers Research,* it was found, however, that not all thick covers are durable, nor are all thin covers fragile. Because the final dimensions of all golf balls must be confined to a very narrow margin of deviation, there must be some other method used to compensate for the differences of cover thickness for the long hitting ball and the

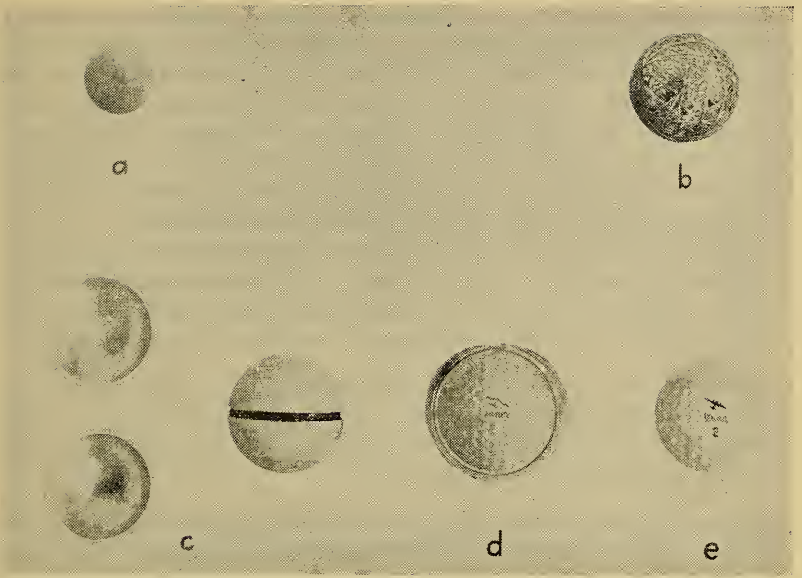

Figure 46. Composition of a golf ball: (a) liquid or rubber center, (b) tightly wound rubber yarn, (c) balata rubber cover, (d) dimple design, and (e) finished product. (*Courtesy of A. G. Spalding and Bros., Inc.*)

durable ball. The core or center of each ball is identical in size, but because the long hitting ball is made with a thinner cover, more windings of rubber under compression can be utilized. The greater the thickness of rubber winding, the longer the distance in flight. Just the opposite is true for the durable ball: a thicker cover and fewer windings of rubber give less distance. Both finished balls have the same outside dimensions. Prior to World War II there were nearly as many types of covers used as there were golf balls. Most buyers for large retail stores and many sporting goods manufacturers now agree that recently the field has been narrowed tremendously, and most golf ball covers, regardless of the name and design stamped on them, are made under the same patent.

As was mentioned earlier, by a recent count at least forty-four designs are used on the golf ball cover. The dimple and mesh designs are the most common, and with all other factors being equal, there is no difference in accuracy or flight distance among balls having either design.

Even the paint on the golf ball should be considered, although it

is difficult for any player, when purchasing a golf ball across the counter, to distinguish between too many and too few layers. Asking questions may help. A ball with three or four coats of paint, all other factors being equal, will give the longest flight and is also the most durable. More than four coats will mean unnecessary weight and will prove no more durable than three or four layers. When less than three layers are used the paint will often crack and chip under normal club impact, causing friction spots.

When purchasing golf balls by written specification and open bidding from manufacturers, or even when purchasing open shelf equipment, consideration should be given to the materials used and the general details of construction, some of which are listed below:

CONSTRUCTION. The ball should consist of a spherical center, tensioned rubber windings and a cover protected by paint. The surface of the ball should have dimple or mesh markings to give long and proper flight to the ball.

CENTER. The center is defined as the sphere upon which the windings are made. It should be of such nature as to produce a ball complying with the requirements designated, and it should contain no material which bleeds into and deteriorates the rubber windings. If the center contains fluid (liquid center) it should not leak or burst under conditions of normal use.

RUBBER WINDINGS. The windings should be compounded of natural or neoprene rubber thread or tape. The properties should not change between minus 10 degrees and plus 120 degrees more than is normal for well-cured material. The aging properties of the ball should not be markedly inferior.

COVER. The cover should be purified balata or gutta-percha compound or equal or superior material, substantially white in color; of such thickness as to produce a ball meeting designated requirements; firmly anchored to the rubber windings; and should not crack, split, or loosen from its anchorage to the rubber windings during any test specified.

PAINT. The paint should be uniformly applied; of adequate thickness to resist normal abrasion; nontacky; free of blisters, dirt, and other foreign material; and uniform in appearance. The paint should be substantially white; discolor little or not at all in storage or on exposure to sunlight.[1]

[1] United States Office of Quartermaster General, *Ball, Golf,* September 28, 1945, pp. 2–3.

COST. *Consumers Research* has tested a dozen well-known brands of balls ranging in price from twenty-one cents to one dollar. They were weighed and measured, compared for uniform surface, distance in driving and accuracy of rolling and putting. The strength and durability of the covers were estimated. The athletic goods section of the United States Army Quartermaster Corps has gone even farther. Their engineers and technicians, with the help of manufacturers, have constructed additional scientific measuring devices.

The United States Army Quartermaster Corps' test for the balance of golf balls is described in Appendix A. However, the unique method of testing for balance and measuring the putting accuracy of a golf ball, as devised by *Consumers Research,* might be used equally well. The aim was to determine uniformity of roll over a flat, ideal putting surface. Balls of each brand were allowed to roll down a trough of specified length and inclination onto a short-nap rug which was brushed before each roll so that the nap lay in the direction of travel of the golf ball. The geometrical position of the point at which each ball came to rest after each roll, was plotted and put on graph paper. By this test it was seen that some balls which were well balanced rolled in almost the same direction each time, while others would deviate from one side to the other.

As found by *Consumers Research,* the most important and only constant difference between a good low-priced ball and a good high-priced ball was the variation in price. No difference revealed by the carefully conducted test measurements would indicate that the higher-priced ball would have longer life or be likely to give a golfer a lower score than the lower-priced ball. In fact, a thirty-five cent ball was one of the best of all tested for distance, accuracy of putting (balance) and durability of cover. Perhaps it is ironic that this same ball had a specially patented cover, "which due to the cost of manufacture," according to the advertisement of another brand, "can be provided only on balls selling for fifty cents or more." A much publicized dollar ball, on the other hand, was advertised "as tough as the toughest" and a "championship ball so tough that every golfer, good or indifferent, can play it economically," and yet was found to rank last among twelve in the impact test for resistance of cover to hard use.

Much of the publicity needed to sell various brands of golf balls and clubs comes from public endorsement of a product by professional athletes. One of the largest manufacturers of golf equipment employs twenty-one professional golfers to endorse clubs and balls. Three of the top four manufacturers each spent $50,000 or more last year for salaries and commissions to the professional players who

endorsed their equipment. The fourth refuses to employ endorsers but instead sells golf equipment on the idea that high price helps rather than hinders sales. W. R. Searles, when discussing the fact that Johnny Bulla had just won a major national golf tournament with a forty-five cent ball purchased from a drugstore, writes:

> Consternation probably reigned at that moment among the leading (golf ball) producers who suddenly realized that Bulla was unattached so far as they were concerned and playing a ball from a price range that might demoralize the market.[2]

Well might the leading producers have such fears when it is realized that the retail value for golf balls sold in 1948 was $22,000,000. Golf club sales totaled $25,000,000.

Clubs

Golf clubs fall into somewhat the same realm as golf balls when the purchaser relies solely upon advertising in making a selection.

WOODS. The heads for so-called wood clubs are usually made from one of four materials. The most common, most publicized and best known is the persimmon head, made of wood from the persimmon tree. (For physical properties of persimmon wood, see p. 309.) The least expensive driver, brassie, or spoon is usually advertised as a genuine persimmon head. Actually all that such a description tells the purchaser is that the wood in the type of club head came from a species of the persimmon tree. It does not indicate anything about the drying period, grain, or quality of the wood which may be of low grade.

Seasoned persimmon clubs usually are in the middle price class of the golf wood family, but the purchaser of this quality of club must watch for necessary requisites other than the dryness of the wood as indicated by the word seasoned. Is the grain close together and in even layers? Is there any sign of small knots, machine tearouts or a rough inlay face? Will the inlay face chip under a normal driving impact? A selected seasoned persimmon head if on a club made by a reputable golf club manufacturer should imply that the head was chosen for its close, tight grain; that it was seasoned properly over a long drying period; that there are no knots or minute cracks and that the head has been tooled down by trained craftsmen. Often, even though the quality is indicated by advertising and selling talk, one or more of these necessary requisites has been passed over or

2 W. R. Searles, "This Month in Golf," *Sports Age*, 32:33, July, 1939.

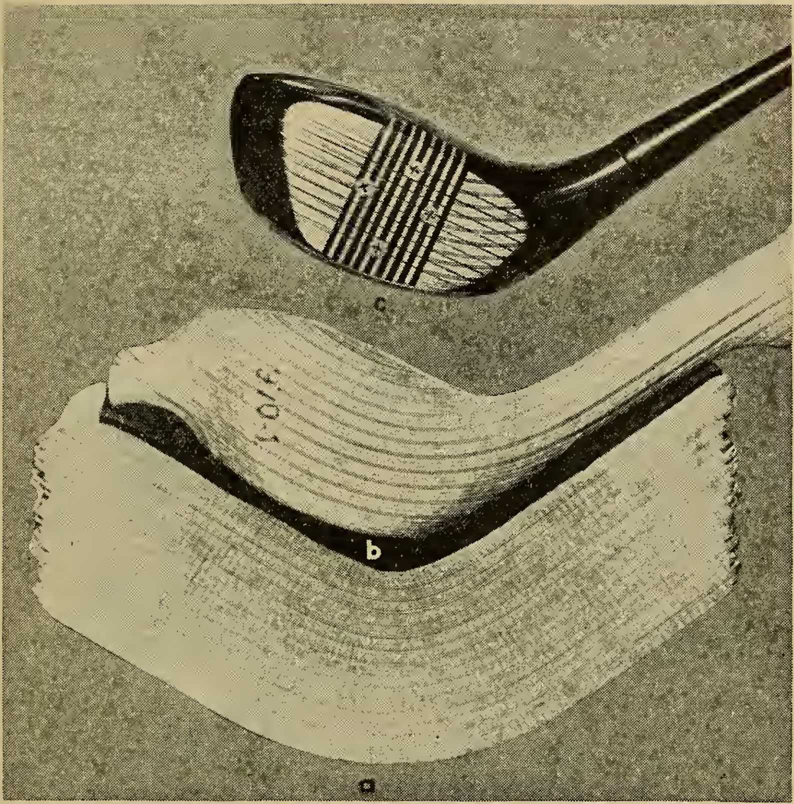

Figure 47. Three stages in the development of a golf wood: (a) compressed wood, (b) club head—rough form, and (c) finished club. (*Courtesy of Wilson Sporting Goods Company.*)

completely ignored. A selected seasoned persimmon head club is usually the most expensive of the three grades of persimmon head clubs. Because of the close, snug grain, there is a much better fitting of screws, face inlay and shaft. Inferior grained wood allows a loosening of the parts after a minimum of play.

When purchasing woods, be wary of any that have a heavy dark finish such as deep mahogany or walnut. Such a finish is frequently a covering for inferior grain, machine tearouts or small knots. Because cheaper wood cannot be used, the clubs with a clear finish are usually more expensive.There are more factory rejects, and a correspondingly higher factory unit price results.

A second and less known type of driving head is made from solidified laminations of densely compressed woods, usually maple veneer (see Figure 47). Ordinarily this club is sold at only one price and it equals or slightly exceeds the price range of a top grade persimmon head club. Compression under intense heat of layers of dense wood gives to the club the same appearance found in a close, tight grained persimmon head. It is one of three substitutes that golf club manufacturers are using to supplement the dwindling supply of high quality persimmon wood. The other two substitutes are less well developed. Comparatively few plastic woods are or soon will be on the market. Those who have used them and sell them say that thus far the club has not sold well because of a psychological factor—there is no satisfying click when the club meets the ball.

In turning to plastic heads, manufacturers not only desired a substitute for the dwindling supply of persimmon wood, but also sought a material that was impervious to temperature change and moisture, and maintained a constant balance. At present, four woods (driver, brassie, spoon, and cleek) and a putter are made of one of many types of plastic. Ethyl cellulose seems to be one of the better materials. In recent tests where a plastic head was submerged in water there was less than 1/100 of one per cent moisture absorption.

Durability tests on plastic club heads made of ethyl cellulose indicated that there were no signs of cracking or chipping after 6600 test shots from a driving machine rigged to duplicate actual playing conditions. Since molded plastic in itself is not a dense material, the clubs get their weight by scientifically balanced counterweights imbedded in the head. Swinging weight can be adjusted to meet the needs of the individual golfer by means of removable disks. Such adjustments take only thirty seconds.

The fourth type of material, magnesium, is also a substitute, and is still in the laboratory and experimental stage. Some magnesium heads have been built, but there is not enough data for a fair evaluation. (For information on shafts, see Irons).

Persons who have used all four types of clubs agree that the performance of each is very similar to the other three, that it is the individual who makes the difference. When fully developed, it is thought that the plastic and magnesium head for golf clubs will prove more durable. However, very few golf clubs in sets actually wear out completely, unless used by a school or a group.

IRONS. Just as the quality of wood determines to a great extent the serviceability and durability of a wood club, so the kind and quality of steel used for the head of an iron club determine the value

of that club. Figure 48 illustrates various steps in the evolution of an iron club head. Steel may or may not be used in the least expensive driving heads. If used, the steel is a very low grade. Iron may be substituted. In both cases the head probably has a chrome finish and will be rustproof only so long as the chrome lasts. These clubs are satisfactory for class instruction if care is taken to have the head replated

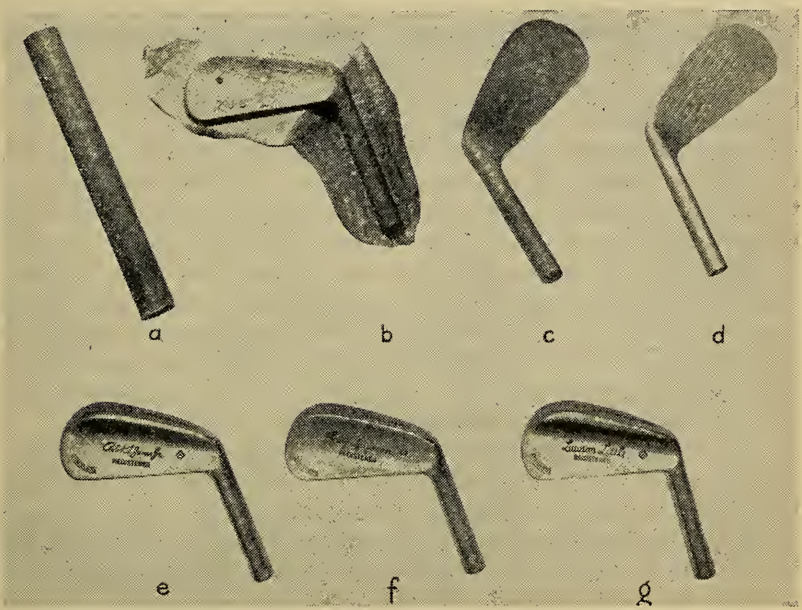

Figure 48. Stages in the development of golf iron club heads and the finished product: (a) a selected piece of steel; (b) after a rough molding; (c) ready for final removal of burrs and roughness; (d) completed club heads; (e), (f), (g) variations in the styling of club heads. (*Courtesy of A. G. Spalding and Bros., Inc.*)

at the first sign of chipping or wearing through. The medium priced iron club head is usually made of a low grade carbon steel and is often advertised as carbon steel. It is not to be confused with stainless steel, for carbon steel will rust if the plating is removed. Stainless steel heads are usually found on the more expensive golf clubs. Only in appearance does this club differ, so far as the head is concerned, from either of the other two types. A similar shot with either of the three clubs will give nearly identical results.

Purchasing agents, coaches and beginning players are often confronted with a new language when selecting golf clubs. Such terms as

goose flange, neck flange, built-in hosel, short hosel compact blade, reinforced wing-rolled flanged back, and lower centered head weight gravity do not mean much to the average purchaser, nor do they mean much in terms of better performance or durability to the average golfer. Many of the phrases have been originated by advertising managers for eye-catching effect for their latest models. There are many head styles, almost as many as there are golf club manufacturers. (See Figure 48). One type of head may help one player and not another; one style of shaft may mean a satisfactory score today and a bad one tomorrow. A good player with one or two practice rounds can use almost any type with equal results.

Along with the driving heads of both the wood and the iron clubs, the shafts of each must receive equal emphasis when evaluating the serviceability and lasting qualities of any golf club. Although steel shafts appeared on the market about the time of World War I, wooden golf club shafts date back to around 1850, when hickory, ash, lancewood, orangewood and others were the principal woods used. Since then steel has superseded the wooden shaft, primarily because it allows the manufacturer greater control and ingenuity in fashioning a strong, light, yet durable shaft. In addition, the amount of material available is almost limitless.

The strength of any steel shaft, despite advertising claims, is about the same. Here again, method of manufacture, added individual features and appearance determine the price range. The less expensive clubs are usually made with polished steel shafts and need careful treatment to prevent rusting. More expensive but not necessarily better shafts are made of chromium or nickle-plated steel. Present information indicates that stainless steel, because of its rigidity, is not used as a shaft material where flexibility and whip are important items.

To some extent, the durability, and to a great extent, the dollar value of golf club irons are determined by the following qualities: type of material used for the head—stainless steel, chrome and nickel plated steel, or polished steel; type of shaft; type of grip—leather, rubber, fiber; and type and strength of binding—whipping cord, waxed linen thread.

SELECTION FOR LENGTH. There are many ways to determine correct length of golf clubs: ask a reputable dealer, consult a school or professional golf instructor, or do it yourself. To determine correct length, stand erect with feet spread approximately the same distance as the width of the shoulders. Then bend the trunk of the body far enough forward so that the arms and hands, when hanging loosely

and comfortably, can swing back and forth (past the hips) without any bodily interference. Next, with one hand above the other, grasp a #4 or 5 iron near the top of the club shaft and rest the club head on the floor or ground. If the sole (bottom) of the club head rests flatly on the surface without having to be pushed away from the body so as to produce reaching, or pulled in so far as to produce a cramped closeness, in most cases the length is satisfactory. A longer shaft will prevent reaching; a shorter shaft will prevent cramping.

There is a difference of opinion on the quality of golf clubs that should be provided for the beginner or the inexperienced golfer. Yocom and Hunsaker recommend a minimum set of inexpensive clubs for learning the fundamentals of the game.[3] The selection of a full set should come later. Nelson[4] suggests that beginners should not use cheap clubs but should rather use a set in the medium price range made by a well-known, dependable manufacturer. In addition, he considers it best to purchase matched irons and matched woods, that is, clubs made by the same manufacturer, the same model, same weight, corresponding length and balance (see Figure 49). Such a set will provide uniformity of feel. A registered set of clubs indicates that by submitting the registration number to the manufacturer, the owner or user may obtain an exact duplicate of any club in the set. A registered set is, in most cases, also a matched set.

For the golf beginner, the bare minimum of clubs should be a driver, putter, #3, 5, 8 and 9 irons. Nelson and others suggest that the key clubs in learning golf are the #2, 5 and 8 irons, but urge golfers to complete the set as soon as possible.

There are fourteen standard clubs used in golf today. In an earlier era, these clubs had names, but now they are numbered. The corresponding names and numbers follow:

Woods:

Number 1—Driver	Number 3—Spoon
Number 2—Brassie	Number 4—Cleek

Irons:

Number 1—Driving Iron	Number 6—Spoke Mashie
Number 2—Midiron	Number 7—Mashie Niblick
Number 3—Mid Mashie	Number 8—Lofter
Number 4—Mashie Iron	Number 9—Niblick
Number 5—Mashie	Number 10—Putter

[3] R. B. Yocom and H. B. Hunsaker, *Individual Sports for Men and Women,* 1947, p. 167.

[4] Byron Nelson, *Winning Golf,* 1946, p. 17.

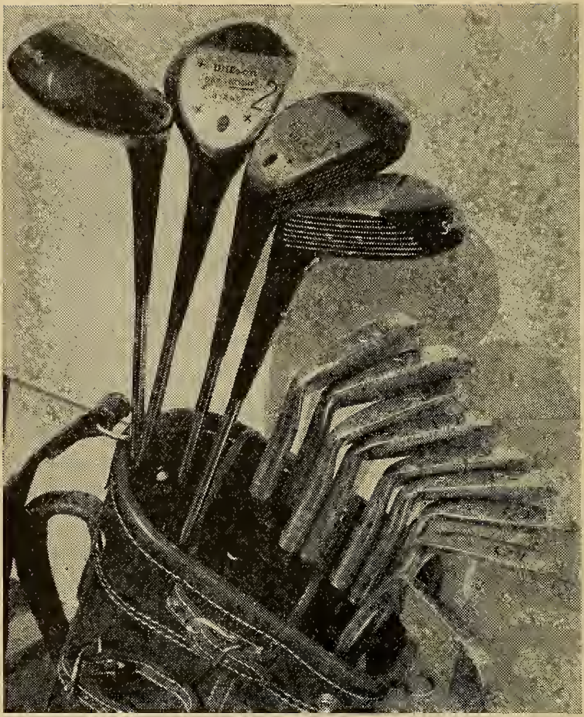

Figure 49. A complete set of golf clubs—four woods, eight chrome irons and a putter. (*Courtesy of Wilson Sporting Goods Company.*)

Prior to the ruling by the United States Golf Association, it was the custom of some golfers to carry substitute clubs, often as many as eighteen or twenty in a single set. Protests made by caddies over the extra weight of the bag led to the decision that a set must be limited to fourteen clubs.

Head Covers

Nearly all types of head covers are made to the same size specifications and generally by similar processes of construction. In selecting head covers, choice should be made between types of materials desired and appearance (see Figure 50). Covers made of selected steerhide, horsehide, "genuine" leather, tackle twill or one of many other materials will provide adequate protection for clubs under normal conditions. Price varies with material. In caring for head covers, dry

slowly and thoroughly when wet. Specific care varies with the material, leather needing more attention than tackle twill or poplin. To prevent loss of head covers, attach the cover to the golf bag or to the other covers with a string.

Golf Bags

Selection of golf bags depends upon individual taste and appearance. In addition, the weight and the number of clubs to be carried

Figure 50. Head covers for the four woods. (*Courtesy of A. G. Spalding and Bros., Inc.*)

should be considered. A bag made of fabric usually is considerably lighter than a deluxe leather bag. Leather trim for a fabric bag adds appearance but needs extra care. In general, bags should have a carrying strap, a handle, tee and ball pocket, and a hood. A shoe pocket and club dividers are optional. Weight is an important item. When clubs are used in inclement weather, a bag with a plastic bottom is suggested.

Accessories for Group Instruction

As golf is accepted more and more into the physical education programs of schools and colleges, there is increasing activity in building

golf courses and new indoor practice facilities to accommodate the increased interest and participation. An important part of the golf instruction is an adequate space with the necessary equipment for practice driving, iron shots and even putting.

For the driving range, various types of teeing surfaces are available. In selecting the type to use, the life or durability and cost of maintenance are primary factors. The heavy-duty tee mat made of strips cut from truck or bombing plane tire carcasses is perhaps the most widely used. Made of a resilient rubberized fabric, this type of mat provides a nonslip, firm footing and, if properly constructed, will last under any weather conditions for many years. The better makes are woven on rust-resisting steel wire, and since they are reversible, provide for double duty. The strips of the mat section should lie in direct line with a target, thus serving as a guide for direction. They are practical for both wood and iron shots, and will not damage or scratch a club. This type of mat is usually made in sizes of 5 feet by 5 feet and 5 feet by 4 feet, but other sizes can be purchased on special orders from manufacturers. Peg tees may be used with this type of mat, the tee fitting between the rubber strips. The best heavy-duty mats should be at least one inch in thickness.

Rubber tees for mats are more expensive at the start, but have proven more economical in the end if the driving range is used hard and often, since they save loss and breakage of wooden tees. Most rubber tees will fit any type of tee mat. Reports on the wearing qualities of one of the better known brands of these tees show that 1200 to 1500 balls may be played from each tee before it needs replacement.

Cocoa mats of the better grade might be provided for shots with iron clubs and may also be used for wood club shots, but are best adapted for use with irons. At the best they are short lived and if subjected to hard use, they will need replacement often. When installing them, care should be taken to see that the surface of the mats is on the same level as the surface on which the player stands when hitting the ball. Unnecessary wear and digging occur when the player is on a lower level. If used outdoors, the mats should be held in place by securing them at the back end with four long staples, one side only of each staple being inserted through the mat. This allows the mat to give somewhat with the club impact and results in longer wear.

Automatic tees which operate with a hopper to hold balls are available. Balls are teed up mechanically, some by pressing a foot pedal, others automatically by a mechanism that picks up and tees a ball immediately after one leaves the teeing device. Although auto-

matic tees are used by commercial golf driving ranges, they are not practical, because of cost and maintenance, for the majority of golf programs included in the physical education curriculum in schools and colleges.

There are many ingenious mechanical devices available for the retrieving of golf balls from the driving range. These range from the expensive pick-up roller pulled by a jeep or a large scooter to a simple stick with a tin can tacked to the end of it. However, class participation in policing the area is probably used more often than mechanical means.

When purchasing used, repainted or reprocessed balls for practice, sources of supply should be carefully investigated before an order is placed or a contract signed. If no other means of testing is available, a clinker golf ball can easily be spotted as one which, when hit squarely off the tee, gives little or no click sound and fails to render a fair account of itself in flight. Fluff balls or rubber sponge balls can also be used for practice.

Balls out-of-round, badly cut, split open or with covers partially loose should not be used for regular play but are good enough for practice in sand traps.

If wooden tees are used on the driving range and the "casualties" are high, use the carrot type of tee since it will reduce breakage losses to a minimum.

The purchaser of physical education equipment should exercise care in the selection of clubs to be sure that the weights and lengths of shafts suitable for players of different heights and physiques are available. He should not forget the women or the left-handed players when purchasing. For the average male player, the driver and brassie should be 42 to 43 inches long and weigh from 13 to 14 ounces. The spoon is the same weight but the club sometimes has a shorter shaft than the other two.

Playing golf during thunder storms is not recommended. Steel shaft clubs, especially, attract lightning. For the same reason, golf umbrellas should have wooden shafts.

Costume

Regardless of the weather, golf goes on. This statement is doubly true for it refers not only to the fact that golf is played the year around, but also to the set-up of the game itself. A golf course covers a wide area of terrain. In case of a storm the way back to the club house may be long and devious with little available protection against the elements, so play usually continues short of a torrential

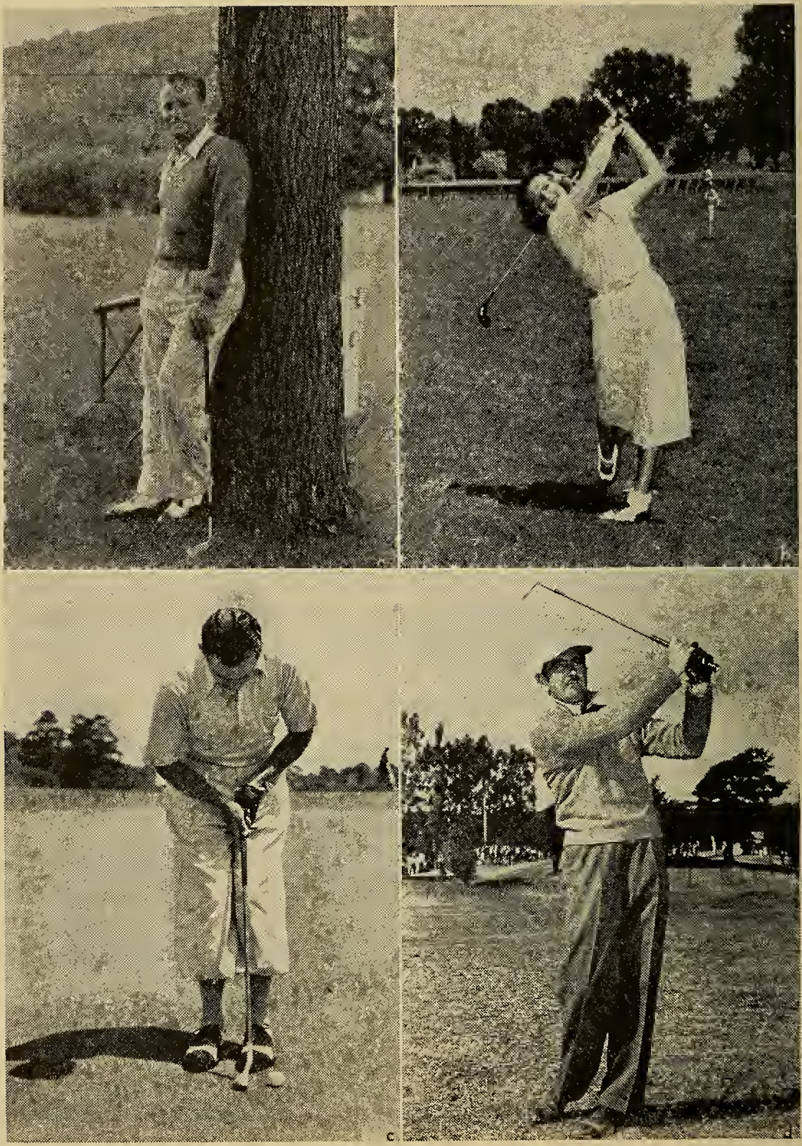

Figure 51. Clothing worn for golf: (a) long sleeved pullover sweater, (b) typical golf attire for women, (c) knickers, (d) typical golf apparel (men) for a cool day. (*a and b—Courtesy of A. G. Spalding and Bros., Inc.; c and d—Courtesy of Wilson Sporting Goods Company.*)

downpour or hurricane. These conditions have direct bearing on the kind of costume worn for golf. Both warm and cold weather apparel are essential to a year-round player, and provision should be made for protection against wind and rain (see Figure 51).

Freedom of shoulder action is another property that merits special consideration. Strong, vigorous action centers in the upper part of the body and arms during a golf swing. There is considerable strain and tension across the shoulders and from shoulder to waist. This implies the need for garments that have ample elasticity or construction for give in these areas at the same time that a trim, unhampering fit is retained at the waistline.

COOL CLOTHING. Lightweight sweaters, shirts, skirts, dresses and pants are suitable for wear in warm weather.

Sweaters. Lightweight sweaters are serviceable and attractive. Short sleeves contribute to coolness and women like the shirt-type sweater that has a collar and is less severe in appearance than the collarless style. Lightweight wool jerseys of this style are excellent. Many players prefer to wear sweaters, either a pullover or cardigan type, over a shirt, blouse or dickie (see Figure 51).

Shirts. Cool, lightweight, absorbent fabrics, usually but not necessarily cotton, are excellent for wear during warm weather. The shirt is short sleeved and should be of sufficient length to remain under the skirt throughout the golf swing. As a rule women golfers do not care for two-way style shirts that can be worn in or out over the skirt, since these interfere with arm action (a hazard that is both mental and physical).

Skirts. Skirts should be styled for neat, trim fit at the waistline and fullness below the hips to permit an easy, comfortable stride and freedom when bending over to tee up the ball or line up a putt. Too much fullness, however, is to be avoided since it hampers movement and, on a windy day, can cause much annoyance (see Figure 51).

Dresses. Selection can be made in either one- or two-piece styles. The same action features listed for sports dresses in general are basic to functional golf dresses. Construction that permits arm elevation without raising the skirt line appreciably is very important. Additional styling features, peculiar to golf dresses follow: pockets large enough to accommodate a score card, (score cards usually measure 3 inches or 6 inches), cigarettes and handkerchief, (players who keep these items in their golf bags will not be concerned with this feature); pockets should be so placed that they do not interfere with arm

swing; side or back placement of pockets on skirts obviates this difficulty. Nonessential but helpful styling features are pockets and belts that have loops or tabs in which tees can be placed. Some belts also have space for placement of cigarettes. Buttons or slide fasteners on pockets permit the player to bend over without dislodgement of the pocket contents.

Pants. The traditional, most accepted style of golfing costume for women has been the sweater-shirt-skirt combination, or dresses. Men have worn slacks or knickers, sweaters and/or shirts. In the last few years, the tremendous popularity of shorts and slacks (and to a lesser extent, culottes) has seen a carry-over of these garments for use on the golf course by women also.

The "short" short is not considered good etiquette in golfing circles, in spite of the fact that occasionally it is seen on the golf course. In school and college physical education programs for purposes of economy in time or expense or both, students may wear shorts for class instruction on the local golf course or for informal play if the institution has its own course. However, most colleges do not require a gymnasium costume for this activity, but seek to educate their classes in correct taste in dress as well as in etiquette of the game itself. Slightly more accepted are the long shorts that reach just above knee level and are worn by women. Shorts are rarely if ever worn for formal tournament competition.

Some men may prefer knickers to slacks. These pants were very popular with men during the early days of golf and up to World War I. Since then, long pants (slacks) have become more widely accepted. Knee-length hose (usually wool) are worn with the knickers. (See Figure 51.)

For women, culottes have the advantage of resembling skirts and at the same time giving the freedom associated with pants. They are worn by some players but not to any great extent. Together with the long flannel short, they are comfortably warm on cool, windy days.

Slacks are used more generally by both men and women, and with greater acceptance than either the long shorts or culottes. They have been particularly popular for cold weather wear. Their use as part of the standard golf attire for men may account partly for their acceptance and use by women. However, dresses, shirts, sweaters and skirts are worn by more of the leading feminine tournament and club players throughout the country.

WARM CLOTHING. Skirts, shirts, sweaters and slacks in heavier, more closely woven or knitted fabrics are suitable for wear in cold weather (see Figure 51). Long sleeves in both sweater and shirt are preferable.

Sweater sets, a combination of pullover with matching or contrasting color cardigan, are excellent for women on days of in-between weather that is nippy but not cold enough for a jacket. The value of slacks for comfort on a cold day has been mentioned previously. When greater warmth is needed, jackets that are large enough to fit comfortably over a sweater or shirt and are snug and trim at the waistline are suitable. These garments should be wind resistant and lightweight.

RAINY WEATHER CLOTHING. Jackets that are water repellent are essential for this type of weather. Some men prefer knickers to slacks, since these shorter pants do not get as wet when the player walks through the rough. Lightweight plastic raincoats that can be folded and stored in the golf bag when not in use, are very serviceable. Plastic coverings for men's hats are also serviceable for wear during rainy weather.

OTHER ITEMS. Women may wear *stockings* and *socks,* or socks alone with golf shoes. Men usually wear socks or half-hose. These vary in weight with seasonal temperatures and according to player preference. Color of hose should harmonize with the color of the costume, or match well some particular item of color on the clothing such as a scarf, sweater or hat. Cushion sole socks, preferred by many men, are not generally liked by women, since there is no shape to the ankle. If peds are liked, they can be purchased in either cotton or wool. Peds are worn by women in place of or in addition to socks. As mentioned previously, heavy, knee-length, wool hose are worn with knickers. The hose folds over the knicker, just below the knee.

Protection against the sun is important to health and good play. Either *sunshades* or *hats* with brims may be worn for this purpose. Hats for women are available in lightweight fabrics such as cotton and linen or in winter fabrics such as flannel, and may be secured in colors that match the dress. Men may wear white linen caps, lightweight felt, or straw hats. Linen and cotton hats have the added advantage of being washable. In some hats for women, the head size can be adjusted. Hats that have visors and ear flaps (ski caps) provide extra warmth for female golfers in cold weather. Sun glasses are preferred to hats or sunshades by some players. However, in very warm weather as the player perspires these have a tendency to slip out of position.

The standard golf *glove* has a leather palm and fits securely at the wrist. The glove fingers are usually cut off so that the finger-tips and first knuckle are exposed. This provides greater freedom and ease of grip. However, some gloves have regulation finger lengths. The entire glove may be leather or the back may be string.

Medium-broad or flat-heeled *shoes* for women are a must. Saddle shoes are suggested. If special golf shoes are purchased, select for comfort and size which will allow two pairs of thin or one pair of heavy socks to be worn (see Figure 52). Leather oil and shoe dubbing will prevent the leather from cracking and will reduce water seepage. Shoes should be cleaned after each use; shoe-trees add extra wear. If the leather tops are in good condition, resoling and new cleats cost less than replacement.

Figure 52. Golf shoes. (*Courtesy of A. G. Spalding and Bros., Inc.*)

Care and Repair

Suggestions for the care and repair of woods, irons, bag and balls follow.

Woods

Always wipe dry with an oily rag clubs that have been out in the rain or used on wet grass. Moisture left on the club will disfigure the finish and cause the club to loosen by opening up the grain of the wood. When the wood dries, especially in clubs with fancy inserts of other materials, the hitting surface begins to warp and crack. A common error of some players is putting a dried-out club in water, hoping that it will tighten up the screws and other fittings that may be loose, through swelling.

When through for the season, put a few drops of linseed oil on a rag and wipe the club thoroughly, then take another rag with a mixture of a few drops of oil and a little shellac and give wooden

heads of clubs a vigorous rubbing. This will coat the surface and help repel moisture.

If any inserts such as ivory or fiber have become loosened, it is best to give the club to a person experienced in repairing golf equipment or to return the clubs to the factory. If the surface has become scarred, remove old finish with a scraper or piece of glass, then smooth with fine sandpaper. For refinishing, darker colors seem to be most popular and serviceable for wooden clubs, but this is a personal matter. The important factor is to apply stain with a rubbing motion that will distribute it evenly and to apply it in a very thin coating. Luster can later be obtained by rubbing with a linseed oil and shellac mixture. It is quite simple to make minor repairs on golf clubs, but leave the more intricate work to skilled artisans.

Perhaps most practical to the school or college with golf as an integral part of its physical education program is the following method used in completely refinishing golf club woods. It can easily be done in an industrial arts department or in the athletic repair section of the physical education department. Individuals who take great pride in their clubs and who have a few spare hours of leisure can increase the length of usability and the appearance of those clubs immeasurably. There are several other methods which might be used, perhaps with equal results, but this treatment is highly recommended:

1. Sand persimmon head down to the raw wood.

2. Apply a walnut, mahogany or black water stain, as preferred. Dry twelve hours.

3. Warm clubs on radiator or in oven to about 100° (too hot to be comfortable to the bare hand). Heat quickly rather than in an hour or so.

4. While hot, dip into a sealer made up of three parts of gasoline and one part of four-hour varnish. Leave until violent bubbling, caused by varnish driving the hot air out of all open pores, ceases. Let cool and then wipe clean with a hard-finished cloth like cotton broadcloth from a discarded shirt. Let dry overnight in a room of 80° temperature.

5. Make a filler with a silex base with the mixing ratio of one pound of paste to one pint of thinner. The thinner should be one part turpentine and two parts standard gasoline. Apply the filler generously, let the gloss become flat, then pat it carefully. Wipe with a clean cloth and let dry about two days in a warm room.

6. Spray or brush on a coat of four-hour varnish which has been slightly thinned (about a 10 percent reduction) with pure turpentine. Lay on a full but not heavy coat free of sags and ripples. Let dry twenty-four hours.

7. Sand, clean and smooth with No. 6/0 sandpaper.

8. Repeat as in 6.

9. Dry, sand, and apply final coat. Dry three days in a warm room.

10. Leave in the full gloss if desired, but the dirt and mud will clean off more freely and the finish will appear more satisfactory over a longer period of time if the final coat is rubbed with FFF pumice stone, felt pad and crude oil. When the rubbing is completed, leave on the sludge and with a pad of cotton waste dipped in water, rub the heads for the final finish. Wipe clean with dry cloth and polish. Let dry at least a week before using. An occasional rub with the cotton waste pad will keep the clubs looking fine over a season of hard play. As a final caution, shellac or lacquer should not be used for the final coating. They will cause chipping and flaking.[5]

Irons

Iron clubs, particularly when they are steel shafted, require little care other than periodic cleaning and a frequent inspection of leather grip and cord bindings. In the event that the head of a wooden-shafted iron becomes loose, it must be removed from the shaft and reset after the shaft has been wound with sufficient string or twine to insure a tight fit. Such work should be done by an expert club maker.

To clean iron clubs of the type not made of rustproof materials, use medium-fine emery cloth. If a finishing touch is desired, polish crosswise on the heel and toe of the club face, thus adding greatly to the appearance. A buffing wheel in the home or school can save a great deal of labor. Immediately after iron clubs are cleaned, the heads should be covered with a thin coating of light machine oil or petrolatum.

Woods and Irons

If the grips of any clubs have become loose, or if a change in thickness is desired (the size of the grip makes a great deal of difference in the feel of the club) first remove the string at top and bottom of the leather and then unwind the leather. The material under the leather

[5] Ralph G. Waring, "Refinishing Golf Clubs," *Industrial Arts and Vocational Education,* 26:218, May, 1938.

may also be uneven and rough. If so, it is best to remove a layer until the surface is smooth. In building up the desired thickness, wrap a number of one-inch wide strips of shirting spirally downward from the top. The material used in building up the thickness as well as the leather itself must have a sticky surface to hold it in place after it has been wrapped. One of the best ways to obtain such a surface is by use of a high grade tire tape. Wrap a layer of tape, a layer of cloth and then more tape. Usually the shaft is large enough to require only one or two extra layers under the leather to give it the desired size. Try the leather over the tape and cloth to see if the grip has been built up sufficiently for the proper feel.

After the material for the base has been shaped, leave a top layer of cloth to which to add paste, glue or shellac to help hold the leather in place. Take the leather as it was unwound and fasten the top to the upper end of the shaft by means of a tack (if the shaft is wood) or tightly-wound wire (if metal). Since the winding determines the grip, it is best to start slowly and wrap securely. While winding the first lap be sure the edges of the strip overlap; then as it spirals down the shaft see that the strip fits snugly against the preceding turn. It is of importance to keep an even tension on the leather as it is wrapped.

Black linen twine and whipcord used in binding shafts that have split or loosened and in binding grips in place are especially prepared. Seldom does any substitute prove as efficient and as durable. Any of the manufacturers of golf merchandise can supply this binding at a nominal cost. It is a bit heavier than the heaviest of shoemakers' thread, and is treated to insure long wear. After the cord winding is tightly wrapped and securely bound, coat the strings with shellac. Not only will this help in preserving the cord, but it will add luster to the appearance.

Clean and polish all clubs at regular intervals. Check sole plates of wood clubs frequently to see that they remain tight; also check for nicks. Use a file to smooth out nicks to prevent damage to balls. Be sure that care is taken with iron club heads so that the edges that come in contact with the ball are rounded and not sharp. Removing sharp edges and deep nicks with a metal file will save many balls from being cut by topped shots.

Bag

Handle carefully any type of golf bag and do not throw it forcibly to the ground. Depending upon the material, brushing, cleaning, and oiling lengthen use. Wire frames that clip into the bag and ensure an upright standing position are suggested since the greatest

wear results from dropping the bag as each stroke is played. Supporting wire frames increase the durability of most bags immeasurably. Such frames or stands usually are made in two sizes: medium for sets up to eight clubs; heavy-duty for sets of nine to fourteen clubs.

Replace broken straps or mend them with leather and rivets. Repair loose or broken handles in the same way.

Balls

Never put into play on a moist turf a golf ball that has been lying in the hot sun, without first cooling it. Such play often splits the ball.

Wash balls frequently. Where a large number of balls are used for group work, cylinder-type wooden tub washers are ideal. Metal tubs tend to knock off too much paint.

For schools, drying racks can be made with two by fours covered with ½ inch mesh wire or screening. The rack can also be used for a washing or spraying rack if balls are dusty but not soiled.

Balls furnished to students or balls purchased for practice purposes should be as clean and white as possible. Blackened, badly soiled balls are lost easily. Extra dirty and soiled balls can be whitened if a small amount of bleaching agent is added to the lukewarm water in which balls are washed.

CHAPTER X

Ice Hockey

The game of ice hockey is not old when compared to many of our athletic contests. Hockey was started in Canada about seventy years ago, but there is a great deal of controversy as to exactly when and where. It is believed that hockey on ice evolved from shinny, a game with no goalie and few rules. Many historians believe that the first ice hockey was played with a rubber ball batted up and down the ice. Later a flat piece of wood was substituted for the ball, and then the present rubber puck was introduced. Hockey sticks have varied from crooked tree branches to the present tested and highly polished rock elm sticks. Little or no padding was worn in the early years of the game, but as skills and speed of play increased, hockey coaches became safety conscious. Today's ice hockey player is as well protected as the average football player.

Equipment

Stick	Helmet
Skate sets	Puck
Shoulder pads	Uniform
Shin guards	jersey
Elbow pads	pants
Tendon protector	jacket
Gloves	hose

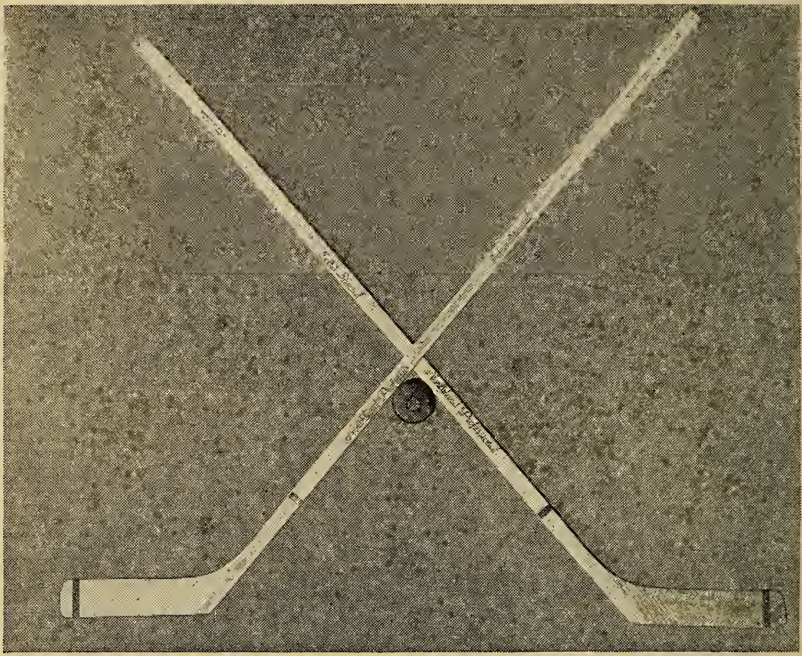

Figure 53. Ice hockey sticks and puck. (*Photograph by Sid Alpert Productions, Washington. Courtesy of Uline Arena.*)

Stick

Next to a pair of shoe skates a stick is the most important piece of equipment used. It is important to fit the stick to the player, that is, to select the proper lie for him. A lie is the angle between the stick blade and the handle (see Figure 53).

Sticks are manufactured in ten sizes or ten lies. A player who carries the puck close to his body will need a stick with the least angle and in an extreme case, would use a No. 10 lie. The player who carries the puck out as far as possible in front of him would need the opposite extreme: a stick with the greatest angle between the blade and handle, or a #1 lie.

Actually, #1, 2, 9 and 10 lies are very seldom used. Only a few players use a #3 or an 8 lie. Most manufacturers make sticks only with the #3, 4, 5, 6 and 7 lie. The others can be had on special orders. A stick with the correct lie is selected for proper balance and feel, preferably with the help of the coach who knows the athlete's skill and style of play.

The handle length of the stick is selected by means of personal standards: that is, the length that gives the best feel and the best control of the puck. Hockey sticks may be shortened to any length but may not exceed 53 inches from the heel of the blade to the end of the handle. Players on the college level or above usually use a stick between 50 and 53 inches long; high school, 46 to 50 inches; and junior high, 44 to 48 inches.

The blade depth may also vary but may not exceed 3 inches. For college and high school players, 2 to 2¼ inches is recommended; for junior high, 1 7/8 inches to 2 inches. The length of the blade shall not exceed 14¾ inches.

At present, all hockey sticks are made of wood—some of one piece, others of two or more pieces. Top grade sticks are made of seasoned elm wood and should have the grain sealed as a means of protection against water. Other sticks are made of white ash. In the lower price range the same types of wood are used but the quality changes. Regardless of the type of wood or the cost, hockey sticks are not guaranteed against breaking. There is no known reliable evidence to show that either the single-piece stick, or the joined stick will break sooner than the other. Laminated blades are better than solid one-piece blades. The most expensive sticks are the lightest in weight; the least expensive are the heaviest.

When ordering sticks from a dealer or manufacturer, mention the desired length and depth of blade, length of handle and whether it is a right- or left-handed stick. If ordering by the dozen for a squad, the ratio of seven lefts, three rights and two neutrals is suggested. Most players shoot the puck from the left side.

Skate Sets

Regular hockey shoe skates should be purchased for ice hockey. Figure skates or speed skates should not be used. Hockey skates are designed with a short, highly-rocked blade, suitable for quick starts and fast turns. The skate shoes should be snug fitting but not binding. Allowance should be made for one pair of wool socks and for a slight stretching of the leather uppers. For lightness and comfort kangaroo uppers are the best.

Professional models are, in most cases, handmade, and when ordering these, exact foot sizes should be sent to the manufacturer. The more expensive skate sets should include most or all of the following features. Top grade shoes should have genuine yellow-back kangaroo uppers. The heel should be narrow and form fitting to ensure a comfortable snug fit. Stiff molded counters and a steel shank give addi-

tional support to the foot. The toe should be a solid oak leather box or a laminated box. If laminated, it should be at least 4 ply. A suede leather lining is best, and the shoes should be fully lined. The goal skate sets are quite similar in this price range, except that there should be an armored toe and counter protector of heavy cowhide to give the goalie added protection for net skirmishes.

Medium-priced skate sets are satisfactory for nearly all but top-flight professional competition. The shoes are usually of black elk tanned leather (specially tanned cowhide) or blue-black kangaroo and should be fully lined. Genuine suede leather lining is best for comfort, but a leather lining reinforced with heavy duck webbing is just as durable. A built-up arch support and molded heel counters are essential. Black elk and chrome leathers are used for the shoes of the less expensive hockey skate sets.

The tongue of the shoe should be lined with chamois, sheepskin, fur or felt for added comfort under the necessarily tight shoe laces. Many players prefer flat cloth laces to the round or thick leather lacing because of greater comfort. Cloth shoe strings must be changed much more often, however. Hockey shoes have both soft- and hard-toe construction. The hard box toe is recommended because of the additional safety features.

The sole of a skate shoe will seldom wear out or have to be replaced. For this reason, nearly any type of shoe construction will suffice. The McKay stitched shoes are recommended as are the Goodyear constructed shoes.

When selecting skates for ice hockey, the most important item is the blade. As a general rule, price is a good index of quality when purchasing skates, for the better the steel, the higher the cost. Although the purchaser can judge quality in many types of athletic equipment, this is almost impossible when considering steel used in skates. With other factors even, the higher the carbon content of the steel, the better the quality. A sharp blade is needed for hockey and the better the metal, the sharper the edges of the blade can be honed. A diamond-tested tooled, tapered blade is the best. The narrower the blade, usually the more expensive the skate. For protection against rust, all blades should be chromium or nickle plated. Chromium is better. Other types of plating or finish do not last and the blades are likely to rust.

Pads, Guards and Gloves

Many types of hockey pants have built-in kidney and hip pads. If this is not so, or when additional protection is needed, most players

wear a light hip pad very similar to that used in football. The same is true for shoulder pads. Two types of pads are available, the flat pads and the cantilever pads. The latter give more protection but are often too heavy and cumbersome. Such a pad may restrict arm movements. The flat pads are lighter and less bulky, consequently give more arm freedom.

Foam rubber shoulder pads are recommended, but are not practical for most high school and college teams because of cost. In this type of pad the one worn by the forwards should be shorter than that worn by the defense players. The difference in size allows for greater freedom of shoulder and upper arm movements. The foam rubber should be covered with airplane silk or some other moisture-resistant covering. The leather binding around the neck should be soft and pliable, preferably sheepskin. Not quite so protective but usually more practical for school competition are the shoulder pads with a filling of felt or kapok covered with fiber strips and duck or twill. The fiber shoulder caps should also have a felt or kapok protective filling. Least expensive but not recommended for organized competition are the pads with a quilted kapok or felt foundation and no fiber for the necesary outside protection.

Shin guards for ice hockey are very similar to those used for baseball. Most of them are made of corrugated waterproof fiber, have either felt or rubber padding at the knee and may have felt or leather slings. Shin guards that do not have leg straps are held in place by tight fitting hose. Defense players often prefer shin guards with a corrugated fiber covering similar to those worn by a baseball catcher. Forwards, if they prefer a little less protection but much less weight, may select a shin guard with rattan strips covered by cowhide. Both types of guards should have foam rubber padding, but just as with shoulder pads, shin guards with felt or kapok padding are more practical for school competition. Guards without rattan strips or fiber (preferably corrugated) are not recommended. Side wings attached to the guard will give extra protection to the gastrocnemius muscle (calf of the leg) and are very desirable but not absolutely necessary.

Cowhide leather elbow pads built up from a foam rubber and rolled hair base and covered with a fiber cap offer the best protection. The elastic at the top and bottom should be of high quality, and it is recommended that an adjustable elastic band be located near the center. Defense players usually prefer a longer pad, one that extends out from the elbow. Forwards usually prefer the short elbow pad because it is lighter in weight. Hair stuffed elbow pads are less expen-

sive but do not offer the same amount of protection as do the foam rubber pads.

Tendon protectors to cover the Achilles tendon offer protective covering in a rather vulnerable area. Such protectors can easily be mounted on shoes when desired. Sizes vary, but 7 inches by 4¾ inches is a standard size. It is suggested that only rigid steel stays covered with pliable leather or wool felt filler covered with leather be used. The shorter tendon protector made of rubber and fabric is less desirable.

Gloves for defense and forwards are made of cowhide leather and are padded with rolls of kapok. Bamboo or rattan strips give added protection on the back. The fingers, thumb and wrists are protected by fiber. Medium-priced gloves are constructed in a similar manner, but only the thumb has a fiber covering. For the lowest-priced gloves, cork or reed is used for protection. In addition to the fiber protective covering, the quality of leather and the type of padding also determine cost. Gloves that have some means of ventilation are preferable to those that do not.

The goaltender, because he is not quite so active, can wear more padding without impeding his skating movements (see Figure 54). In addition, he needs more protection from the flying pucks. The goalie's equipment often weighs between 15 and 20 pounds, depending upon the amount and kind of materials used. The equipment includes leg guards and chest protector besides the regular hockey equipment.

Leg pads for goalies vary greatly in construction and quality. Most types have rattan or bamboo staves running longitudinally with kapok or deer hair packed around them to prevent rebound of the puck. A layer of felt covers the staves, and covering the pad is a layer of duck. Nearly all of the leg pads have a corrugated finish caused by the staves and packed kapok. The pad should be hinged at the bottom, thus allowing the lower portion of the pad to cover the instep and the foot up as far as the box toe. Horizontal staves at the knee allow the upper part of the pad some flexibility and allow freedom for bending the knees. Longitudinal braces continue from the knees well up the thigh. Local hockey rules limit the width of the pads but an 11 inch width for each pad is considered standard. The length of the pads varies and it is important to have pads that fit properly.

For protection of the hip region, goaltenders usually prefer one of two types of pants: the regular hockey pants with the built-in hip pads, similar to those worn by the other five players, or a pair of football pants with the fiber thigh pads and a pair of lightweight hip pads.

Figure 54. Goaltender's equipment. (*Photograph by Sid Alpert Productions, Washington. Courtesy of Uline Arena.*)

Nearly all goaltenders wear some sort of chest protector and the most common is one very similar to that worn by a baseball catcher. In professional ice hockey, the style is the same but the thickness is greater.

According to Goding, the types of goaltenders' gloves are many. Both gloves of a pair are identical when purchased but before they can be used they must be altered. One glove, usually the right-hand, is used for catching and picking up the puck; the other, which holds the stick, is used to stop drives and shots. Therefore the latter must have extra padding on the back. Felt or kapok may be used but these materials add bulk to the glove and interfere with quick hand action. Most goaltenders prefer sponge or foam rubber to cover the areas needing more protection.

All gloves are made of cowhide or horsehide and have a webbing between the thumb and index finger, this to serve as a trap similar to the one used on a first baseman's mitt in baseball. Quality of leather,

amount of padding and type of lining determine to a great extent the difference in cost of gloves. Some of the more expensive gloves cover not only the hand and wrist but also much of the lower arm as well.

Helmets

Many professional hockey players do not wear helmets but all high school, college and amateur hockey players should wear them. Hockey helmets closely resemble boxing headguards and are usually available in two types. The more expensive is made of strap leather, padded with foam rubber or felt and leather lined. The less expensive has a felt lining covered with leather. Nearly all hockey helmets are open at the top except for one or two crisscrossing straps. It is highly recommended that only helmets with chin straps, preferably adjustable, be used and that areas covering the base of the skull and the temples be reinforced with fiber.

Puck

Conformance to official size specifications is the main consideration when selecting pucks. A puck should be no more than 3 inches in diameter and one inch thick. It must be a circular shape and made of vulcanized rubber (see Figure 53). Top grade pucks have the edges rounded and knurled for better gripping to the stick. Pucks with general size and dimension specifications cost about 1/3 the price of official pucks and should be used for practice.

Shirt and Pants

Jerseys similar to those used for football are worn for ice hockey. They are styled to fit comfortably over the protective padding underneath and are reinforced at the shoulders and elbows. Cost of jerseys varies chiefly with the type and quality of the fabric used. The most expensive jerseys are made of wool (worsted), and nylon. An extra charge is made for body and sleeve striping and for jerseys designed with a special lace front. A T shirt is usually worn under the jersey. For further information concerning jerseys consult Football Uniform pages 128–131.

The long shorts that reach just above the knee are usually quilted and have built-in protective padding. The most expensive pants, designed for professionals, have 8 inch inseams, thigh guard pockets, and the most complete protective padding. This includes clipping pads, hip and kidney pads, molded hip bone fibers, and padding that protects the spine and the lower section below the waist. These pants may also have worsted inserts at the fly and crotch. As is the

case in the better quality shoulder pads, foam rubber is used in the protective pads for extra cushioning, and fiber pads are covered with felt. Top quality thigh guards may be edged with a soft leather. In pants styled for collegiate play kapok is used in combination with foam rubber to cushion the hip, kidney, spine and tail fibers. These pants are less expensive than the professional models.

Pants worn for school competition have a 6 inch inseam and, in the less expensive models, have split fibers padded with felt for thigh protection. Better quality pants for this group have corrugated fiber thigh guards that fit into the thigh guard pockets. Hip and kidney pads are made of kapok and quilted cotton and extend above the waistline.

Jacket

Ice hockey jackets are similar in styling to general athletic jackets (see Gymnasium Costume, page 295), with raglan sleeves and knit collars, cuffs and waistbands. Leather jackets are the most expensive. Lighter weight jackets are constructed of cotton (usually gabardine or poplin), and rayon (usually satin). Braid, piping, and the use of contrasting colors add to the cost.

Hose

Long wool hose that extend well above the knee are worn over the leg padding. Less expensive hose are constructed of wool and cotton, and the cheapest hose are cotton. Hose must be full cut to fit over the padding. An extra charge is made for striping.

Care and Repair

Hockey equipment which must be expertly cared for includes shoes skates, sticks, pads and helmets.

Shoes

Give the same care to hockey shoes as to other types of athletic leather footwear. Oil shoes frequently, check them often for broken stitching and keep them as dry as possible. See pages 264–267 for additional suggestions.

Skates

Sharpen the blades after every second or third use. If blades are narrow, use an oil-stone to sharpen them. Electric grinding wheels are often used, but if so insist upon an oil-stone finish to take off the

small burrs and splinters. When leaving the ice do not walk on the blades. Use blade guards. Guards are available in rubber, leather and wood. Rubber is the most popular but leather or wood guards are more durable. Rubber often will split if the blade is sharp.

After each game or practice session, wipe the blade dry. Especially is this necessary on the less expensive skates, since they are the ones that will probably rust most easily. When storing shoe skates for the summer, oil or, preferably, grease the blade with a good protective covering and oil the shoe with a good leather oil.

Sticks

After every game or practice session wipe the sticks dry. Clear lacquer will aid in preventing warping and will maintain a desirable finish. Store hockey sticks on racks, either floor or wall, so that they are parallel to the floor, the blade pointing down. It is almost impossible to repair serious breaks but glue or a screw will prevent further splitting, especially for practice sticks. If glue is used for strengthening joints or repairing minor breaks, waterproof glue is recommended.

A good adhesive or friction tape, when applied over the entire blade often prolongs the life of the stick and assures better control of the puck.

Pads and Helmets

See material on care and repair of football pads and helmets, pages 137–139.

CHAPTER XI

Lacrosse

Lacrosse is the oldest native American game. Historians attribute its origin to the American Indians. It was first played in large groups, usually one tribe versus a neighboring tribe, and the playing field extended for a mile or more. As many as several hundred played on a side. The stick was called la crosse because it resembled a bishop's crozier. Early sticks were made from a branch of wood with a hoop at one end. Strips of rawhide or bark were strung across the hoop to form a pocket. Balls were at first made of rawhide stuffed with feathers or hair. There are indications that wooden balls were also used at one time. In the south and southwest, the Indians used two sticks —one in each hand—similar in size and shape to the present squash racket. The ball was a small, round stone and was frequently carried in the mouth of the player.

The first definite rules were written about 1860 when Dr. George Beers was successful in bringing some semblance of organization to a sport where nearly as many sets of rules existed as there were teams. For his unceasing effort some call him the Father of Lacrosse. In later years, this title was bestowed also on William C. Schmeisser (Father Bill) who played on the varsity lacrosse team at Johns Hopkins University and then for twenty-five years served at that institution as head coach without pay. He was responsible for sending teams to the Olympics in 1928 and 1932. Both teams were victorious.

In the United States lacrosse has been organized as a college sport since 1881, but only in the past ten or fifteen years has it gained a prominent place in programs of physical education in a growing number of secondary schools and colleges. It is a vigorous sport usually played out-of-doors during the spring months.

Equipment

- Crosse (stick)
- Ball
- Goal net
- Uniform
  - jersey
  - pants
  - tunic and blouse
  - shorts and shirt
  - shoes
- Goalkeeper
  - leg and chest pads
  - face guard
  - gloves (optional)
- Other Players
  - helmets and face guards
  - gloves

Crosse

Wood used in crosses must be strong and firm to withstand impact of the ball and contact with other sticks and to resist warping. Clear straight-grained hickory is used in the better sticks and may sometimes have small knots in the handle which in no way affect the wearing qualities of the sticks. Due to the knowledge gained over a lifetime, the workmen (Indians) are able to select the best wood as the stick is being bent and hand carved. Medium-quality sticks have a lighter grain and in the cheapest sticks knotty wood may be used. These latter sticks are good only for the junior players. A cross consists of the following main parts: backbone, angle, tip, guard, bridge, lengthwise strings, cross strings, back bend, collar, and handle (see Figure 55).

The stick should be almost at right angles to the backbone when the guard is tightened for playing. On release of the lead string there is a slight increase in the degree of angle. Corners of the angle are slightly rounded on men's sticks and square on sticks used by women. The handle should be straight and with a definitely marked bend where it meets the backbone.

Firm, smooth backbones are essential for durability and for the ball to travel from the crosse in a true direction. The backbone is generally 1¾ inches high. The guard should be made of raw gut (thick) and well-twisted, about 3 inches high for men's crosses and 2 inches for women. The upright supports of the guard should be strong.

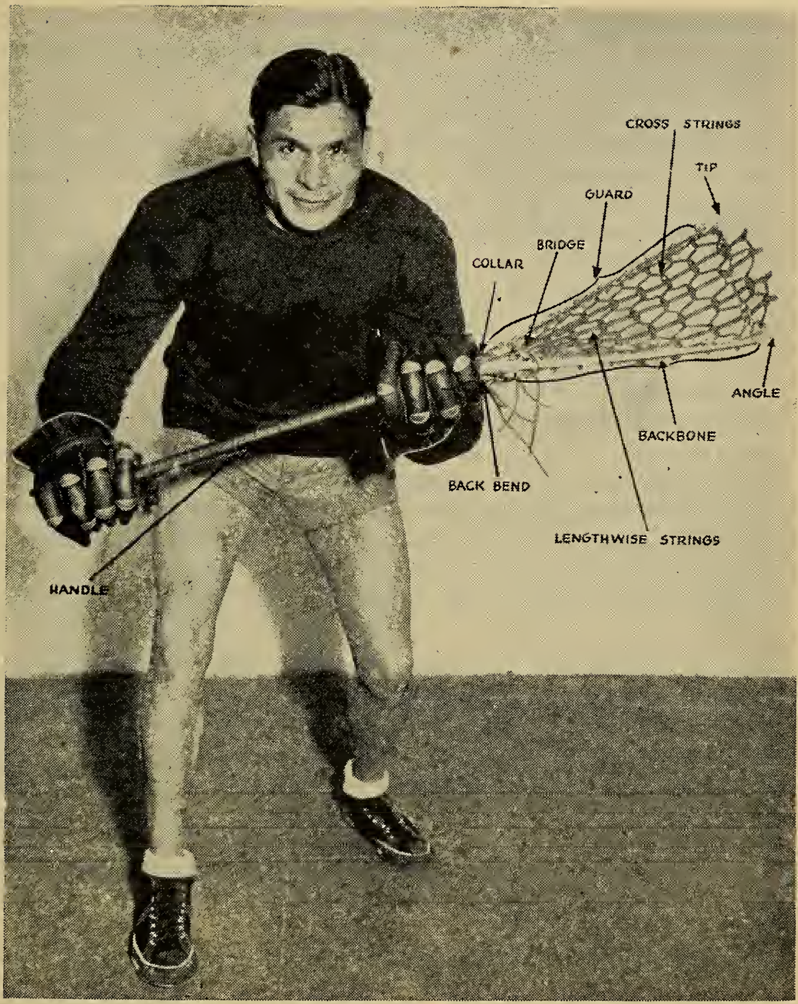

Figure 55. Lacrosse uniform and component parts of a lacrosse stick. (*Courtesy of Bacharach-Rasin Company, Inc.*)

Crosses are strung lengthwise with hide which is then threaded crosswise with a clockgut in the better crosses, and crosstex (a string made of linen and other materials) or leather stringing in crosses of medium quality. The crosstex should always be waterproofed. Top quality sticks have a firm, close weave. An extra string (rawhide) has been added to the better crosses, and the clockgut or crosstex is

attached to this string rather than to the wood wall. This method of construction eliminates the friction of the string against the backbone and results in longer wearing of the string.

When selecting a stick choose one that feels comfortable in balance, weight and length of handle. The wood side of the crosse should naturally be the heavier, and when the crosse is held with the hand at the collar the wood side should balance evenly or may turn toward the ground. A crosse that is too light makes it difficult to execute long throws, is ineffective in crosse checking, and may break easily. Too heavy a crosse is cumbersome, tiring and dangerous. One should be chosen that is comfortable in feel. Women's crosses may not exceed 24 ounces.

A handle that is too long is unwieldy, especially for overhead passes and shooting; one that is too short cuts off the natural reach. For small children it may be advisable to cut off the handle slightly, but this should be avoided whenever possible since it destroys the balance of the stick. A rough estimate of suitability in length can be ascertained if, when the stick is held in playing position, the end of the handle can be fitted comfortably under the armpit. Some players judge length as correct if the crosse, when placed beside the player, extends from the ground to the player's armpit. Rubber grips disturb the balance of the stick and are not necessary to a smooth, firm grip.

The width of the crosse refers to the measurement from the top of the angle to the tip. Width varies in men's crosses depending on the position of the player. An attack player uses a 7 inch crosse; midfield player, 8 inches; defense player, 9 inches; and goalkeeper, 12 inches. Women generally use a 7 inch crosse and junior crosses are approximately 6 inches in width. Left-hand crosses are made for men and not for women because women's rules permit only right-hand crosses.

The bridge refers to the thick gut that is placed several inches above the collar and is attached to the guard and the backbone to prevent the ball from lodging in the crosse. The designation of this area of the crosse differs for men and women (see Figure 55). The bridge is about 3 inches above the back bend and should be level with the guard and tie over the backbone. Attachment to the gut should be secure but with enough play to move along the gut.

Official rules for men specify that:

> The crosse shall be of an overall length of not more than 72 or less than 40 inches (except that of the goalkeeper which may be any desired length). The head of the crosse shall measure seven

inches, nine inches, or 12 inches in width between the tip and the wood wall. (Inside measurement. Tolerance ½″). The crosse shall be made of wood, laminated wood or plastic with the head approximately at right angles to the wood wall. The wood wall shall not be over two inches in height and shall extend approximately 18 inches from the right angle bend of the head to the handle. The handle may taper gradually but shall not be less than one inch in diameter. The center line of the handle shall cross the head approximately 2½ inches from the wood wall. The head and sides of the crosse shall have holes bored in them to facilitate weaving the stringing. The *side wall* opposite the *wood wall* shall be made by weaving gut lacing from the tip of the head to the handle. This stringing must be attached to the tip of the head in such a manner as to prevent the tip from catching on an opponent's crosse. The net of the crosse, roughly triangular in shape, shall be constructed of gut, rawhide, clock cord, linen or nylon cord.

The use of a crosse in which the pocket has been permitted to sag to such a depth that it becomes unreasonably difficult for an opponent to dislodge the ball, or the use of a crosse, the construction or stringing at the throat of which is deliberately designed to hold the ball, or the use of a crosse of trick construction or stringing of any kind that tends to retard the free dislodgment of the ball by an opponent, shall be illegal and the referee may demand that the player adjust the crosse or exchange it for another. If he deems it necessary the referee may also inflict a technical foul penalty.[1]

Official rules for women set up the following specifications for the crosse:

The crosse may be any length. In its widest part it shall not exceed one foot. The weight of the stick should not be more than 24 oz. The wood must be on the right-hand side of the bridge, i.e., left-handed crosses are illegal. A string must be brought through a hole at the side of the tip of the turn to prevent the point of the stick catching an opponent's crosse. A leading string resting on the top of the stick may be used. No string may be fastened so as to form a pocket. The length strings shall be woven to within two inches of their termination so that the ball cannot catch in the meshes. No metal of any kind shall be allowed upon the crosse.[2]

Sticks that exceed maximum dimensions in size and weight should not be used. Sticks that are splintered or damaged in any way should not be used until they have been repaired.

[1] *Official Lacrosse Guide,* 1950, pp. 86–87.

[2] *Official Field Hockey-Lacrosse Guide,* 1950–52, p. 124.

Ball

Only one type ball (rubber) is used in lacrosse and with minor variations is the same for both men and women. The men's rules specify that:

> The ball shall be of white rubber not less than 7¾ inches nor more than 8 inches in circumference, 5 to 5¼ ounces in weight, and shall have a bounce when dropped from a height of 72 inches upon a hardwood floor, of not less than 45 inches and not more than 49 inches. . . . Any departure in color of ball shall be subject to agreement between the two teams.[3]

The ball used by women is slightly lighter. Official rules specify that:

> The ball shall be of black, white or yellow rubber sponge, not less than 7¾ nor more than 8 inches in circumference. It shall weigh not less than 4½ nor more than 5 ounces.[4]

Official balls are perfect, without blemishes. Practice balls have slight blemishes but are perfect in weight and balance. Balls that have become hardened through use and age should be discarded since they can be dangerous in play.

Goal Net

Top-quality nets are made of good grade tarred thread, usually a #36 twine. Tarring is essential for protection against moisture. For maximum durability, the net should be reinforced around the edges that attach to the goal posts. Reinforcement for a depth of 6 inches with double mesh is excellent for this purpose. Heavyweight rope edges are necessary for support of the net. The netting should not be more than 1½ inch mesh. A net must measure at least 6 feet by 6 feet by 6 feet in depth.

Helmets

Helmets are similar to those worn for football, but are lighter and have a visor to protect the eyes from the glare of the sun and aid the player in seeing the ball, especially when catching or intercepting high passes. Visors also protect the forehead and eyes from blows of the stick and ball. The crown of the helmet is perforated for ventilation. Helmets should be well-padded and reinforced; protect head, ears, and back of neck; and be adjustable to the wearer's head. Top

[3] *Official Lacrosse Guide, op. cit.*, p. 86.
[4] *Official Field Hockey-Lacrosse Guide, op. cit.*, p. 124.

quality helmets are padded with sponge rubber and have recessed leather ears and rolled leather binding. Peak and visor should be made in one piece to prevent tearing apart.

Face Guards

According to men's rules all players must wear a face guard. Face guards should be adjustable and detachable. They must afford adequate protection of the face, fit comfortably, and provide a wide angle of vision. Guards are metal and have rubber chin guards to protect the jaw. A center bar attaches the guard to the visor while the lower part of the guard is secured to the helmet with detachable side clamps. Goalkeepers' guards have an additional horizontal bar across the guard close to the visor. In some guards for goalkeepers, the center bar is omitted to give fuller vision. Women goalkeepers may wear a face guard that attaches to the head by means of elastic straps. This protection is optional in women's rules.

Gloves

Long gauntlet style, well-padded gloves or mittens similar to those worn for ice hockey are used by men in lacrosse. Gloves should be durable, flexible, and provide complete protection to the hand and lower arm. All gloves have a reed-inserted cuff and are roll-padded over the wrist, thumb and back of hand. A hair padding is used in top quality gloves and they are made of leather throughout. The palm should be soft and pliable, and the back of the glove strong and firm but styled for complete freedom of movement. Less expensive gloves are made of canvas, reinforced with leather. Felt rather than hair padding is used in these gloves. Mittens should have adjustable finger straps (see Figure 55).

Arm Guards

Various style arm and shoulder guards are worn by men under the jersey. These may be constructed of leather and fiber, white felt reinforced with fiber, quilted canvas, or fiber covered with canvas and padded on the inside. A collar harness on some guards protects this area. Top quality guards protect both shoulder and elbow joints, have a collar harness, are reinforced with leather, and are designed so as to distribute the force of the blow. Arm fibers are adjustable in these guards. The guards extend well down the forearm. A lightweight football shoulder pad can be used under jerseys if the arm guard is not provided with shoulder protection.

Chest and Leg Guards

Chest padding is needed for adequate protection of the goalkeeper and is required by the men's rules, although it is optional for women goalkeepers. According to men's rules:

> Goalkeeper's equipment shall not exceed standard baseball equipment as far as shin guards and chest protectors are concerned.[5]

Pads worn by the men's goalkeeper are similar to those used by the catcher in baseball.

A body protector modeled after an English design is frequently worn by American women goalkeepers. It is similar to the men's protector but has a pad attached to each side of the lower part of the chest pad for protection of the thighs.

Costume

Lacrosse is played in the spring on a grass or dirt field that is approximately 100 x 60 yards, but play frequently continues into areas adjacent to this roughly defined boundary. Games are sometimes played in a field house if weather prevents the use of outdoor playing space.

The wide range of vigorous movements required in lacrosse places a premium on excellent garment design and construction. Shirts must be durable and have plenty of give to allow for flexion and extension of both arms simultaneously, especially in overhead action. Regular gymnasium costume is worn by both men and women in informal play. For tournament or match games, women may wear tunics and blouses and cleated shoes, similar to the costume worn for field hockey (see pages 106–111). Official rules require that players shall wear rubber soles. No spikes are permitted unless they are of rubber. English women and some American players wear leather boots.

Rules for men specify that their costumes shall include:

> . . . jerseys with not less than a 6 inch number on the front and an 8 inch number on the back. The color of the numbers shall be contrasting with the color of the jerseys.[6]

Lacrosse jerseys for men are designed with large shoulders and sleeves to allow for comfortable fit over the padding worn underneath. The jerseys are usually striped across the chest. Low or high topped canvas or leather shoes, with cleats, are worn in men's match

[5] *Official Lacrosse Guide, op. cit.,* p. 87.
[6] *Ibid,* p. 79.

play. These shoes usually lace above the ankle for additional support. For a discussion of cleats and shoes consult page 267.

Care and Repair

Suggestions for care and repair of lacrosse equipment follow:

Sticks

1. Before play, tie the lead string but do not overtighten, as this puts too much pressure on the angle.
2. Loosen the main lead string after play and before storage to remove strain from the angle.
3. In order to avoid pressure on the bridge or guard, hang crosses on a peg or nail, with the weight of the crosse resting against the peg; or place them on a shelf in horizontal position, wood down, with space between the crosses.
4. After play, especially in wet weather, loosen lead strings; remove dirt and mud, and wipe crosse with a dry cloth. Oil the wood with linseed oil after rain, and about once a month rub in just enough to moisten but not soak the wood.
5. Do not oil the guard and bridge.
6. Use a little grease occasionally on the clockgut but never on crosstex.
7. Whenever the lengthwise strings become too loose and form a pocket, tighten each string. Strings should be flexible with some give, but a deep pocket limits throwing accuracy.
8. Straighten the short strings that support the lead strings and form part of the guard. When storing crosses at the end of the season insert small sticks in the guard, parallel to these short strings, to keep the guard upright. A thin coat of shellac applied to the guard will stiffen it and hold it in place. After the shellac dries remove the sticks.
9. An occasional application of varnish or furniture wax protects the wood from moisture.
10. Sandpaper any wood surface that has splintered. Tape small breaks with a very light tape, used sparingly so as not to disturb the balance of the crosse.
11. Mend broken gut by making a split in the broken end as well as in one end of the piece being used for repair, then threading one end through the other.
12. Tape angles that have split. This may prove satisfactory, depending on the extent of the break and the amount of hard use to which the crosse is put.

13. Store crosses in a place protected from rodents. Room temperature of 70 to 75 degrees and 50 to 60 per cent humidity is ideal.

Ball

Rinse balls occasionally in a warm, soapy solution, then dry; store balls away from heat, in a cool, dry place.

Helmet

Consult Football Equipment, page 137.

Gloves

Consult Care of Leathers, pages 303–304.

CHAPTER XII

Racket Games

TENNIS

The history of tennis is confused by contradictory versions which come down to the present time. Several ancient nations are credited with originating the game but in each case, there is not enough evidence to support any such claims. Over the years, the rules and playing area have been changed many times and in 1888 the English Lawn Tennis Association was formed as a national organization to govern the sport. Tennis was introduced to America in 1874 and several clubs were started. During these first few years there were no standard rules or playing conditions. In 1881 the United States Lawn Tennis Association was formed and has since been the national governing body for the sport.

Tennis is played out-of-doors in temperatures ranging from very hot to cool, and climates that include all degrees of humidity. Less frequently, the game is also played on indoor courts. The different types of surfaces used for courts have considerable effect on the balls. Asphalt and dirt courts have an abrasive action; grass courts stain the balls, and when wet, the ball absorbs the moisture and becomes heavier. Wet balls can increase the tension of racket gut stringing. These factors, in addition to other properties necessary to well-functioning tennis equipment, must be taken into consideration by the manufacturer as well as by each individual consumer who selects equipment.

Equipment

Ball	Racket
Net	frame
Costume	stringing
garment	Accessories
hose	racket cover
headgear	racket press
shoes	marker
	tennis robot

Ball

Tennis balls are one of the few items in sports equipment that bear the stamp of approval of a national sports association. Most balls of good quality are manufactured according to specifications established by the United States Lawn Tennis Association. "Approved by the USLTA" is stamped on each ball or appears on the can or box in which the balls are packed. This marking is a guarantee to the customer who purchases or uses the balls that, when the balls were packed, they met the standards of the USLTA for weight, bounce and compression (hardness). Balls that meet such standards are more desirable than those that are not manufactured to conform to these specifications. However, the consumer should remember that approval by the Association does not necessarily guarantee other properties important to durability and performance of tennis balls. Such factors as quality of rubber and felt, maintenance of air pressure over a specified length of time (or amount of usage) are not included in the requirements for approval by the Association. Reliable manufacturers produce balls that meet high quality standards in the items mentioned, but, at present, the consumer's only guarantee of these properties is the integrity of each manufacturer. Balls that fail to perform satisfactorily after short usage can usually be detected quickly by the experienced player. The casual or unskilled player is less able to judge the merit of a ball.

One other factor in relation to official approval of tennis balls is worthy of note. Balls marked "approved" meet the required specifications *at the time* of packing. The usual (though unguaranteed) time during which balls under pressure in packed tin cans continue to meet these specifications is approximately six to eight months. After that they gradually lose their internal pressure and change in bounce and deflection. Conformity to specifications is considerably shorter for balls that are packed in boxes, cellophane bags or other similar containers (six to eight weeks). The date of manufacture is usually marked inside the ball and serves as a guide to the manu-

facturer if balls fail to meet requirements and are returned to the factory for any reason. The consumer has no such guide to aid him in purchasing balls. The balls he uses may carry the stamp of approval but, due to age, may fail to meet these standards. The date of manufacture indicated on the outside of ball or container would solve this problem for the consumer. Since, at the same time, it would create a problem of turn-over for the retailer, it has remained, up to the present, in status quo.

At various times testing organizations have submitted balls to tests of conformity to approved specifications. Unless the balls so tested were from pressure-packed tin cans and were tested within six to eight months after manufacture, they cannot be expected to meet the specifications, but failure to do so is no indication of their non-conformity at time of manufacture. Data obtained from such tests may be misleading to the consumer, if this fact is not made known by the testing organization.

A tennis ball that performs well for a reasonable period of time of hard play must have the following properties: (1) wear resistance of rubber and covering to withstand pressure of contact with racket and ground; (2) aerodynamic properties for bounce and rebound from racket; (3) true sphericity for accuracy in flight and rebound; and (4) resistance to atmospheric changes, especially heat and moisture. According to the official rules of the USLTA:

> The ball shall have a uniform outer surface. If there are any seams, they shall be stitchless. The ball shall be more than two and a half inches and less than two and five-eighths inches in diameter, and more than two ounces and less than two and one-sixteenth ounces in weight. The ball shall have a bound of more than 53 inches and less than 58 inches when dropped 100 inches upon a concrete base, and a deformation of more than .265 of an inch and less than .290 of an inch when subjected to a pressure of 18 lbs. applied to each end of any diameter.[1]

All of these factors are checked and controlled in production by those manufacturers whose balls carry the approval of the Tennis Association. Diameter is checked by means of a series of gauges made of sheet metal approximately 1/32 inch thick. Each gauge has an accurate and true circle of a given diameter cut through it. Weight is checked on a sensitive balance and is usually read in grams. Specialized equipment is used for testing bounce and deflection. The average consumer can compare the bounce of two balls by holding a ball in either hand, then releasing the balls simultaneously and compar-

[1] *The Official Tennis Guide and Yearbook,* 1950, pp. 41.

ing the height of rebound. This is a rough measurement and it must be remembered that the ball with the higher bound may exceed the maximum bounce specification. Too high a bound may make the ball too fast for play, in that it becomes difficult to reach the ball for return.

Balls are made of natural rubber-covered felt and inflated with air or gas under pressure (see Figure 56). It is generally agreed that natural rubber excels the synthetic rubber in all properties required in tennis balls. There have been some claims that there is less leakage of air through the synthetic rubber, which would increase the playing life of the ball even though the performance was less satisfactory. If true, the increased durability of such balls would be more economical in the long run for individuals or institutions for whom durability is the main consideration. The rapid development of cold rubber, for which claims are made that its properties surpass the natural variety, may change the rubber composition of tennis balls. Consult pages 314–315 for a more detailed discussion of this material.

The best quality wool felt is used for the ball covering. This is 100 per cent, long-napped wool felt, usually melton. The Quartermaster Corps specifications (December 1944) for balls purchased by the Army specify that the cover should be long-nap white cloth felt made of virgin wool that contained not more than 2 per cent foreign material based on a moisture- and grease-free condition. Research is still in progress for the purpose of further improving the wear resistance without sacrificing aerodynamic properties which are related to the type of nap on the felt. According to provisions of the Wool Products Labeling Act, the fiber content of the felt, percentage of each fiber type (if more than one type is used), and name of the manufacturer should be indicated on a label, tag or other suitable means of identification. Seams, according to USLTA, must be stitchless. The covering (two pieces of felt, figure eight in design) is cemented to the entire surface of the ball. The seams should be evenly cemented and sunk below the general level of the surface of the felt cover. The covering may be either red or white. The white covering is preferred by most players and is used exclusively in official tournament play. Some players prefer red balls for outdoor use because they find it easier to see the ball against the surfaces of clay, dirt or cement courts.

"Seconds" are balls that do not meet the tests of the manufacturer. They may have only minor defects and are excellent for beginners and others whose game may not require top ball performance. Balls may not be marked as seconds but some manufacturers indicate

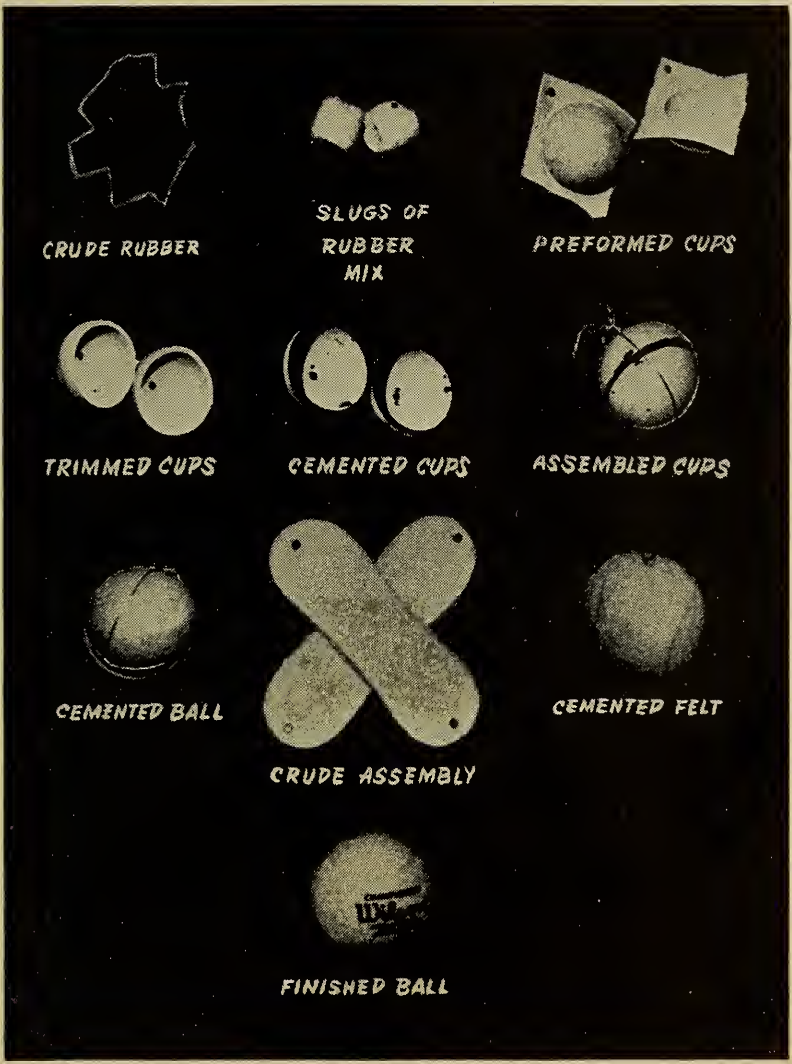

Figure 56. Steps in the manufacture of a tennis ball. (*Courtesy of Wilson Sporting Goods Company.*)

seconds by blocking out the words "Approved by the USLTA" on cans or boxes. Seconds are not sold as top quality balls by reliable retailers. The salesman from whom a person purchases equipment will supply seconds upon request, if these are carried by the store. Balls that meet official specifications cost more than seconds, and balls in pressure-packed cans are more expensive, usually, than those in boxes, bags, or sold loose. The quality of felt used for covering influences the cost of the balls.

Net

The netting, bindings and tape should be durable to withstand pounding of balls, especially at the center of the net, and to resist rain, moisture and mildew. The net cable must be equally weather resistant and strong enough to support the net and maintain correct net height under tension. A net consists of the following parts: netting, bindings (top, bottom and ends), cable, drawstring, tie ropes (top, bottom), grommets, and thread used to sew the parts of the net.

Official rules do not limit the materials that may be used in nets. These are metal, hemp and cotton cord (twine). Nylon nets are not at present on the market. Cotton or hemp nets are used exclusively in official tournaments. The difference in rebound of balls from the top of metal nets may account for their nonuse in tournament play. Initial cost of metal as compared to top quality cord limits the widespread use of these nets to those who can afford to buy in terms of long-range cost. Metal nets cost three to four times more than the best cord nets, but their life expectancy is equally three to four times as great. Some players fear the lack of give in metal—a factor that enters into consideration when players must run at top speed to return net shots.

The best quality cord nets are made with a #48 thread twine; in medium priced nets #30 thread twine is used; cheaper nets are made with a #21, 15 or 12 thread twine. There is a decided difference in the diameter of each of these thread sizes and in the weight of the net—items that are discernible to the consumer at time of purchase. Better nets are reinforced at the center section of the netting, with extra twine added for about 13 to 21 feet in length, and 1 to 3 feet in depth. Italian hemp, made in England, has long been used for top quality netting and cables. This fiber will withstand water better than any other natural textile fiber. For durability and best weathering properties the netting of outdoor cord or hemp nets should be tarred. A plain white (untarred) net is suitable for indoor use. Tarred nets cost more than the plain white variety.

According to the Quartermaster Corps specifications for tennis nets (twine or tape), the body of the net shall be square or diamond mesh no larger than 2 inches bar measure or 4 inches stretch measure. Bindings shall be duck or webbing, 3/4 to 2 1/2 inches wide on each side in the finished construction. The binding shall be folded evenly over the ends and bottom of the net and sewn to the net with one or more rows of stitching. If binding does not have selvage, it shall be hemmed or turned under and caught by the first row of stitching.

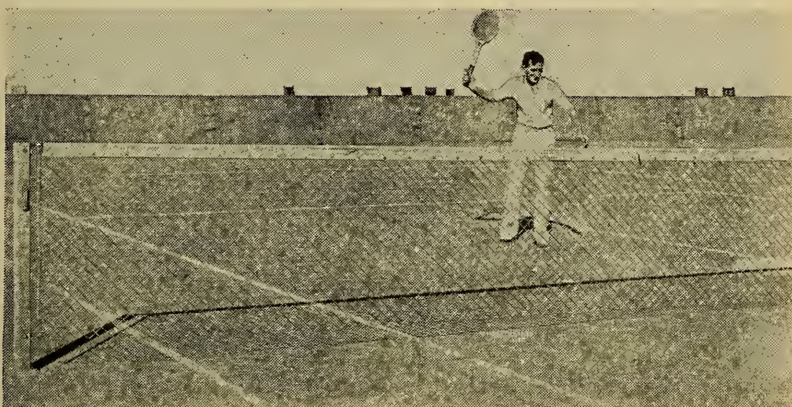

Figure 57. Steel tennis net. (*Courtesy of American Chain and Cable Company, Inc., Page Steel and Wire Division.*)

The top of the end binding shall be sewn into the top tape or webbing. The bottom of the end binding shall be sewn into the bottom tape or webbing. Reeving may be used in place of binding at the bottom of the net.

Quartermaster Corps specifications also require that the top tie rope shall be a #30 cotton twine, and the bottom tie rope a #84 cotton twine, at least 3 1/2 feet long. Brass grommets shall be placed at each corner of the bottom binding, no larger than a #2 size. The rope cable shall be sisal or jute, with a 1/4 inch minimum diameter. If a steel cable is used, it shall be a galvanized steel flexible wire cable, with a minimum diameter of 3/8 inch. The drawstring shall be a three-ply jute twine. Sewing thread shall be a 10/3 or stronger cotton machine thread. All ends of rope and twine shall be secured with cord or clamped with a metal rope clamp to prevent unlacing.

Metal nets should be made of heavy, stainless steel. Low carbon steel will rust. This type net can remain outdoors in all kinds of weather without damage. On some metal nets the tension can be ad-

justed to control the rebound of the ball without affecting the height of the net (see Figure 57).

The official rules of the United States Lawn Tennis Association provide as follows:

> The height of the net shall be 3 feet at the center, where it shall be held down taut by a strap not more than 2 inches wide. There shall be a band covering the cord or metal cable and the top of the net for not less than 2 inches nor more than 2½ inches in depth on each side. . . .
>
> The net should be 33 feet wide for a singles court, and 42 feet wide for a doubles court. It should touch the ground along its entire length and come flush to the posts at all points.[2]

Nets for doubles courts cost more than singles nets of comparable quality.

Racket

One of the leading manufacturers of tennis rackets has estimated that the average racket made in its plant passes through eighty-seven operations and twelve inspection stations during the process of its manufacture. It is difficult to conceive of such a multitude of operations when the racket is seen as a finished unit. Generally, the production of a racket includes the following processes: (1) logs are cut into boards, then into strips that follow the grain of the wood as closely as possible; (2) basic parts of the racket are coated with glue and placed in a bending machine for shaping into a frame—these include handle plug and throat wedge, inside bow reinforcement, laminations and fiber strips (formerly, frames were steam bent to the desired shape. Today, with the use of laminated frames, most rackets are coldbent, that is, the laminations and other racket parts are coated with glue, placed in a hydraulic pressure jib and later into a kiln. This method reduces the danger of the frame warping. The entire bending operation can be accomplished in 45 seconds.); (3) holes for the stringing are marked, drilled and grooves made from hole to hole; (4) handle flakes, throat reinforcement and shoulder overlay are added; (5) the frame is sanded and finished (filling, lacquer and polishing), decalcomanias and bindings are applied; (6) weighting is added and butt caps and leather grips are applied; (7) the racket is strung. These steps represent the high spots in construction. The racket goes through numerous intermediary steps (see Figures 58 and 59).

[2] *Ibid,* p. 50.

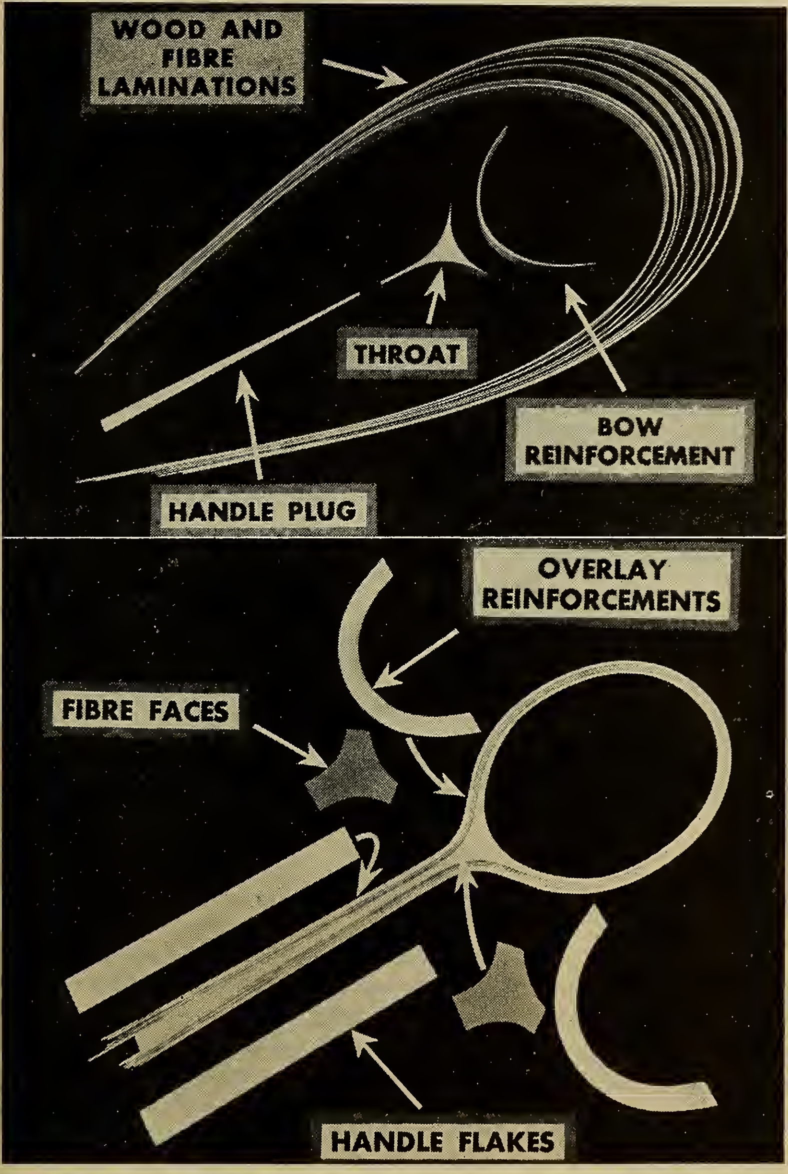

Figure 58. Component parts of a tennis racket. (*Courtesy of A. G. Spalding and Bros., Inc.*)

FRAME. The frames of top quality wood rackets are made from clear, straight-grained, well-seasoned, second growth ash. Six to twelve annual rings per inch for tennis stock in second growth ash is considered the best to use. Under six rings the danger of splitting increases, while over twelve, ropiness or excessive flexing, occurs. Red and white ash are both used in tennis frame construction, the red as a trim or contrasting color in high grade models and as an entire lamination in lower grade frames.

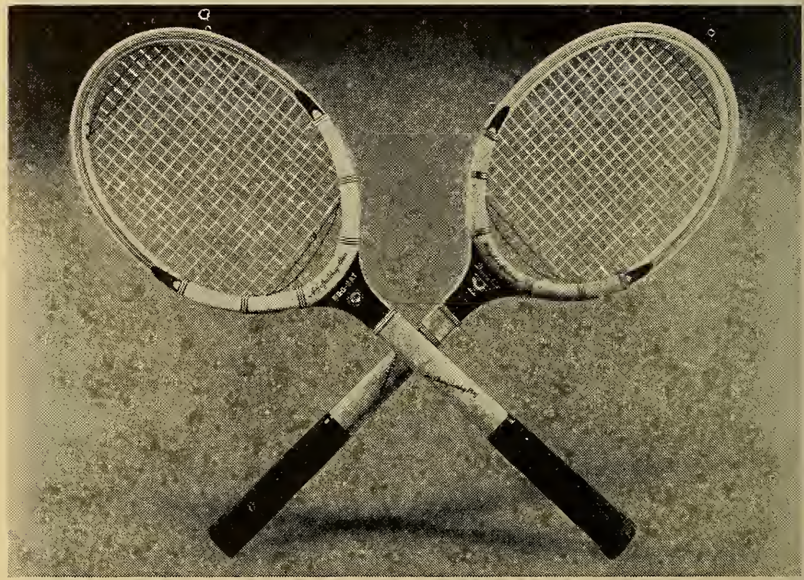

Figure 59. Tennis rackets. (*Courtesy of A. G. Spalding and Bros., Inc.*)

When selecting a racket the straightness of the grain is easily discernible in the racket head if the racket has been finished with a clear, light finish. The frame is laminated (plied), that is, it is composed of a number of strips of ash and fiber that are molded to form one continuous piece of wood. This process results in a much more durable frame. An outer strip of beech or other hardwood may be added for additional strength. As many as eleven laminations are used; but rackets of comparable quality and only six to nine laminations stand up equally well, if not better, under stringing pressure, and perform excellently, according to many who are acquainted with both aspects of racket functioning. Laminations extend into the grip

and are always visible in the racket head where they can be counted by the purchaser. The darkness strips are fiber. The most recent Quartermaster Corps specification for rackets requires that the number of ply shall not be fewer than five.

Although official regulations do not prohibit the use of rackets other than those made of wood, comparatively few rackets are constructed from any other material. Metal rackets lack the natural feel that most players are accustomed to in a wood racket, and, with the exception of greater durability, they have little to recommend them. Another factor that militates against their use is that the strings are inclined to cut into the felt covering of the ball. At the present time plastic frames are not on the market. Regardless of the method and type of construction, rackets should be strong and flexible; for true flight of the ball, the frame must be straight. This latter quality can be checked by holding the racket straight out in front of the body with the short strings perpendicular to the ground, and glancing down the handle and frame.

Maple or beech is used in the throat of the racket. These hard, compact woods with little grain are needed at this point of greatest strain. A racket designed with an open throat is weaker than one that is closed at this section. An overlay is placed on the throat and shoulders of better quality rackets to give additional strength. The overlay is sliced from a piece of hard wood which has been previously steam bent into a half moon shape. Finished overlay will measure approximately 1/8 inch thick and 3/4 to one inch in width and extend across the throat and up the shoulders of the frame about 3½ inches or 4 inches. The purpose of the overlay is to reinforce or tie the throat and bow sides together in combination with a maple or other hardwood throat reinforcement that glues inside the bow also in a half moon shape and to the same length as the outside shoulder overlays. This stiffening of the throat and shoulder sections resists warping and twisting at these points which might tend to allow strings to loosen if the shoulders were weak enough to bend or collapse with stringing tension. Quartermaster Corps specifications require that overlays be performed to avoid cross grain. It has been estimated that the frame arches as much as 2½ inches back of the handle line when an expert hits a hard shot. A shoulder overlay helps to eliminate this sharp action.

A throat overlay (a piece of veneer, fiber, or plastic sheet cut to the shape of the racket throat and glued securely in position) adds to the strength and helps resist splitting of the throat wedge itself and adjoining glue joints.

Handle flakes of basswood and more recently of malacca are used to form the grip of the racket. They are covered with leather and so are not visible to the eye. These may extend just above the leather grip and give great flexibility to the handle, or they may be longer flakes that continue to and over the throat overlay (Australian style). In the latter type all the whip of the racket is in the head. In the top quality rackets calfskin rather than leather is used on the grip. According to Quartermaster specifications the leather grip shall be as follows:

> . . . vegetable-tanned, smooth or perforated calfskin 2/64″ (2 ounces) minimum thickness. Finish shall be non-glazed and pliable. The leather shall be treated or impregnated to improve its resistance to slipping and to preserve the leather.[3]

Cheaper rackets may have rubber, plastic or imitation leather grips. The length of the grip covering should be at least 6 inches to insure adequate coverage for all hand sizes. Both top and bottom of the covering should be finished neatly and firmly bonded to the wood. A plastic or cord trim is usually used to bind the top of the grip. The leather butt at the bottom of the grip should be tapered and firmly attached to the handle.

Since rackets are exposed to varying atmospheric conditions of temperature and moisture content, the frame should be finished with a clear, water-resistant lacquer that will not flake, crack or whiten. Before application of lacquer, the wood should be sanded smooth and filled. All decals, extra trimmings and similar finishes are added for eye appeal and, although they contribute to the cost of the racket due to added cost of labor, they add nothing to its performance. Top quality rackets are trimmed with nylon string rather than plastic. Endorsement of a racket by a leading player adds to cost usually, but adds nothing to the quality. Excellent rackets are produced without any name endorsement. However, a racket that bears the name of an outstanding player or coach is usually of top quality.

Too many holes weaken the frame. There should be a maximum of eighteen main strings and twenty cross strings, evenly spaced. String trebling at top and bottom of the frame should not be less than two rows at each end. Outer holes, and any inner holes that are not parallel with the strings, should be smoothly countersunk. The top holes should be joined by grooves (about twenty) that are deep enough to protect the strings. Best results are obtained if grooves are cut by hand, that is, the racket is held by an operator and moved

3 United States Office of Quartermaster General. *Racket, Tennis, with Press*, Amended February 13, 1947. p. 2.

from hole to hole by hand as the grooves are cut by a high speed small diameter router bit.

A comfortable weight and grip are essential to good play, and differences in strength and size of hand grip require variations in size of tennis rackets for each sex and for different age groups. Table 13 indicates the average measurement in size and weight of rackets for different groupings. A player may prefer a racket that falls outside these classifications, due to individual differences and personal preference. These sizes are suggested rather than prescribed.

Table 13

Measurements for Tennis Rackets

	FRAME			*GRIP*
	Length	*Width*	*Weight*	
Men	27″	9″	13½-14 oz.	4⅝″-4⅞″
Women	27″	9″	13-13½ oz.	4½″-4⅝″
Juniors (9-12)	26-27″	9″	11-13 oz.	4″-4½″
Young (below 9)	24″	9″	7-11 oz.	3¾″-4″

Specifications for length and width are approximate—minor variation in these dimensions may occur with differences in design of racket head and throat.

Too frequently young players and juniors learn tennis using rackets made for adults. These rackets are usually too heavy, too long or too large in grip, and faulty habits in stroking, plus undue fatigue, result. However, a racket that is too light and poorly constructed is likewise a poor buy, and many of these have been sold for the young player by stores that handle sports equipment only as a very inconsequential side line, without acquaintance with the necessary specifications, quality of wood and other essential information. As soon as a child can handle the regular size racket with comfort and without overfatigue he should do so. Play with a racket that is too light beyond a needed period of time may cause tension and overhitting, since such a racket contributes little to ball momentum. Standard (adult size) rackets cost more than those that are made for juniors and youngsters.

Rackets identical in size and weight may vary considerably in balance. Rackets may have any one of three balance points—heavy head, heavy handle, or even balance. As a general rule, players who specialize in a baseline game prefer a racket that has most of the weight in the head, for added power in drives; net players and those who attack consistently with volley and smash, like rackets

that are evenly balanced or are lighter in the head. The addition of tape or an extra grip, or the cutting down of the handle destroys racket balance and should be avoided. The best way to test balance is to swing the racket that meets individual balance requirements.

The width of the bow and shoulders and the width of the entire frame viewed sideways varies with different manufacturers. Claims are made to support these differences. At present no published tests of comparison have been presented as evidence that this factor appreciably lessens or increases racket strength and flexibility. Until the superiority of any special type of construction is substantiated by valid and reliable comparative tests, these differences may be considered merely as selling points. Similar variations exist in throat construction. Throats may be made from one solid piece of wood, three pieces, or be multi-laminated.

Regardless of variations of construction, certain basic features are essential to any well-constructed racket. These are present, in a lesser degree, in medium quality rackets and may be completely absent in rackets that meet only the minimum standards of quality: *frame*—top quality wood, at least 6 to 9 laminations; *shoulders*—reinforced, with overlay; *throat*—reinforced, with overlay; *handle*—basswood, beveled and fine, perforated, grooved leather, at least 6 inches; *stringing*—top grade split and twisted lamb's gut or nylon; *finish*—rounded edges, smooth, top quality veneer and weighting that does not weaken handle.

STRINGING. The average player requires a racket stringing that will have give, resiliency and speed adequate to the demands of the type of game he plays. Highly skilled tournament players need stringing that is extremely taut and fast. In this group performance is primary, with a consequent decrease in durability requirements. Stringing must be sufficiently strong to withstand the impact of the ball at varying speeds without breaking and without losing resiliency over a reasonable period of time. In addition, properties of strength, resiliency and tautness must be maintained during varying weather conditions of heat and moisture.

Various materials are used for stringing, including both natural and man-made products. Gut and nylon stringing predominate; silk is fast disappearing since it is being replaced with nylon. When selecting stringing the player must consider the function it must serve. This will include such factors as skill of the player, intended use—tournament or practice play—and climate. Cost will be a deciding factor for some players.

Gut. At the present time the best grade rackets are strung with lambs gut (high quality lamb intestine casing) which has more resilience or life than any of the other types of stringing. Gut is produced in different grades, and may be whole, split, or recoiled for additional strength. Since gut is a living organism, it is subject to change according to atmospheric conditions and cannot be guaranteed to maintain uniform standards of performance. In damp weather the tension of the strings increases, and prolonged contact with damp or wet grass and balls will cause the strings to swell and break. Over a period of time gut loses tension. It is, therefore, better to buy a racket frame and then have the gut stringing added (when purchasing a racket in which gut is to be used), so that the desired tension may be secured. A tension of 50 to 60 pounds is average. Top-notch players use as high as 80 pounds tension, but these rackets must be restrung after every match. Tests to determine the correct tensions to use when stringing rackets were conducted by a leading tennis professional and the String Research Department of Armour and Company. A review of the findings is described as follows:

> Here are the conclusions, arrived at after over 500 tests in which both amateurs and professionals, of all grades of ability as tennis players, tested their accuracy with rackets strung at varying tensions from 40 to 80 pounds. All of the stringing tensions mentioned are precision tensions based on "dead weight" measurements according to the U.S. Bureau of Standards. The frames were strung by experienced stringers using an approved stringing tensionizer. The reason for pointing this out is that there are various stringing tools now being used that do not give the correct tension as indicated by that particular unit.
>
> 1. Moderate string tension gives the average player greater control of the ball and greater accuracy in shotmaking.
>
> 2. "Board tight" stringing causes a rapid drop-off in accuracy.
>
> 3. "Board tight" stringing results in far more rapid wear on gut, and far greater loss of shape in frames.
>
> 4. The more expert the player, the higher the string tension at which maximum accuracy in shotmaking is reached.
>
> Since the ability to win tennis matches calls primarily for the ability to place the ball somewhere near where you are planning when you hit it, it is obvious that the tension which permits the greatest accuracy is the one to use. Until the rules of the game are changed, the ability to "belt 'em" won't account for nearly as much as the ability to place 'em to a desirable point in the opponent's court.

> The results of the test permit the instructor, for the first time, to give his pupil scientifically accurate advice on the tension to which his racket should be strung. They permit the player to determine, with the same degree of accuracy, the tension that suits his own game. And lastly, they show the player how to get extra sets of tennis out of a good frame and good gut—by playing with rackets strung to the moderately tight tensions of 55 to 60 pounds.[4]

Gut is supplied in lengths of 15 to 21 feet so as to give a selection of lengths needed for the various sizes of rackets. Most tennis strings are available in two gauges: 15 and 16 gauge (Browne and Sharpe standard). Gauge 15, the heavier of the two, is the best for all-around play, and it has sufficient diameter to give excellent wear and durability. Gauge 16 is thinner and should be supplied only for tournament play where maximum resiliency is required and durability is of secondary importance.

Nylon. Nylon, a man-made synthetic fiber, has been on the market a relatively short time, but its use is increasing so rapidly that it presents a very serious challenge to all the older, well-established fibers. This is equally true when stringing for rackets is considered. Nylon is fast replacing silk stringing. It is competing with gut for predominance. At the present time gut is preferred by many skilled players. Improvements in certain properties and construction of nylon filaments may change this preference within the next few years. Nylon stringing can be purchased in two forms—multi-filament and mono-filament. The former type has a less smooth surface and contributes to ball spin similar to the action of twisted gut.

Among the advantages of nylon can be listed the following: resistance to atmospheric conditions, especially moisture—nylon will not contract or expand because of atmospheric conditions; uniformity in all properties including size and quality, since it is manufactured under controlled conditions; cost—good quality nylon is cheaper than gut.

It is considerably more difficult to string a racket with nylon as contrasted to gut due to the elasticity of nylon. Care must be exercised to eliminate this stretch in order to get accurate tension. Players claim that nylon lacks the tightness in stringing that is found in gut and is, therefore, not as fast. Nylon has about 80 per cent of the resiliency of gut. Another complaint against nylon by players has been the frequent breakage of strings especially in the multi-filament stringing. The Quartermaster specification for nylon stringing states:

[4] "Science Checks Up on Racket Tension," *Sports Age*, May, 1940.

> The type of Nylon used for strings shall have a melting point not less than 200 degrees C. and a specific gravity not over 1.10. Strings shall be round, smooth and have a uniformly translucent appearance. The diameter of the nylon string, measured at any point, shall not be out of round by more than 0.002. . . . Tensions from 50 to 55 lbs. are recommended for the average player.[5]

The consumer can make a rough test of the tightness of the racket strings by pressing with thumbs on the strings. There should be very little give. If the stringing is taut, it will make a ping sound when the fingers are flicked against them. If injured or marred, nylon stringing may break off abruptly.

Racket Cover

Covers for rackets should be water repellent, and, if possible, the inside should be moisture absorbent. Covers may be secured in rubber or rubberized fabrics, heavy, waterproof cotton fabrics, chamois, nylon and plastic. Rubber is apt to dry up and crack. Plastic should be a fairly heavy quality to be durable. Side fastener closings are preferable to the drawstring or snapper type because they provide facility in opening and closing and better protection against moisture.

Racket Press

Racket presses are made in several shapes, but the hexagon or square-shaped presses provide greater protection and more evenly distributed pressure than presses of other designs. Presses that screw into the center of the racket stringing should be avoided, as the screw cuts into the stringing. The wood should be of the hardwood variety and varnished or lacquered. Bolts should be plated to prevent rusting. Some presses hold as many as three rackets.

Marker

Two types of markers are available—wet and dry. Choice will naturally depend on whether the court is marked with a wet solution (lime, usually) or powder (dry lime). Markers vary in their gallon or pound capacity. The price varies accordingly—the greater the capacity the higher the cost. Additional features found in the more expensive markers are a regulator that controls flow at all times and a brush attachment that insures straight even line marking.

[5] United States Office of Quartermaster General, *String, Nylon, Tennis and Badminton,* July 10, 1945, p. 2.

Tennis Robot

A tennis robot is a machine that tosses balls into various parts of the court mechanically. The machine is electrically driven, and can be adjusted to simulate different types of shots at varying speeds. It is a luxury item that only a limited number of schools, colleges or community groups can afford. In previous years there has been on the market a robot that was operated by hand. This type robot may still be available, and is considerably cheaper than one that is electrically powered.

Costume (Tennis, Badminton, Squash)

Tennis and badminton are played in temperatures that may be extreme in heat, but are rarely, if ever, cold. Games seldom take place in the rain unless an occasional storm comes up during a match. Play is usually discontinued until the rain stops. When played indoors temperatures are comfortably warm. Squash is played indoors only and courts are usually not heated. The nature of these sports makes cool, lightweight clothing essential, with provision for additional warmth when needed by the use of warmer fabrics and a sweater.

Costumes styled for freedom of action in all directions are most essential. Styling for action of the arms overhead is particularly important for tennis and badminton. Most shots in squash are underhand.

Above all else, costumes for tournament racket games must be white. This is the *sine qua non* of costume etiquette for these games, and those who break this tradition do so through ignorance, or seek attention through this type of exhibitionism. Comfortable sports clothes of any color may be worn for informal play, but there is a logical reason for the wearing of white. This neutral color gives to all players a uniformity that centers attention on the strokes and game itself, rather than on details of the players' dress. This is a conservative practice and is in keeping with the tradition of sport for sports sake, a concept that is basic to all racket games. General sportswear, including sport shirts (one-quarter sleeve for men, never sleeveless), shorts, slacks, dresses (short) and sweaters are worn for tennis.

Slacks, particularly white flannels, are worn only by men. Good quality flannel is expensive. Lightweight wool and heavy cotton gabardine are also popular fabrics for slacks. It is a matter of personal preference whether slacks or shorts are worn. Slacks should be fairly short to prevent tripping. Players lose weight during a strenuous game, especially in warm weather, so waistbands that are adjustable or lined with a nonslip band, are important.

The medium length short is preferred by most players, both men and women. Some players wear the long short, a style that is liked particularly by players from other countries.

In the case of sweaters there is a slight deviation from the unwritten law of all white. Bands of red and blue frequently decorate the sweater neck line and waistband. A cablestitch pattern is popular for tennis sweaters. Sweaters are usually worn only for warm-up and during rest periods, but some players wear a sweater throughout the match or practice period.

Tennis dresses are equally as popular as the shirt and short combinations for women. These are similar to play suits but are always styled for action. Many dresses have pleated or circular skirts and cap sleeves. Some are sleeveless, others have short or full-length sleeves. Dress length ranges from just below the knee to 4 to 5 inches above the knee. Length of dress should be governed by body build and age, as well as by personal preference for various styles (see pages 338–339.

White blazers, sometimes trimmed with white braid on collar and front openings, are attractive and appropriate accompaniments to the tennis costume. Club or team emblems may decorate the pocket. A scarf worn under the blazer helps to keep the neck and shoulders warm, and looks neat and attractive.

Heavy or medium-weight wool socks are preferable to a lightweight wool or cotton. The wool absorbs perspiration and also serves as a cushion for the foot, especially on cement or asphalt courts which are hard on the feet.

Various types of headgear are worn for protection of the eyes against the glare of the sun. Some players like caps with peaks, others prefer eyeshades that may or may not have crossbands that fit over the top of the head. Caps and visors are always white, and usually have green lining in the underside of the peak. The crown of the cap may have ventilating eyelets. Felt, flannel and duck are used for caps and visors. The felt is excellent for absorption of perspiration. Hats with head straps that are adjustable or which have elastic inserts are practical and comfortable. Men who perspire profusely may wear head bands with perforated air vents. However. these do not offer protection to the eyes against the sun.

Canvas shoes, sneakers as they are sometimes called, are always worn for tennis and have been adopted for use in many other sports as well. These are white, flat-soled, heel-less shoes with rubber soles and canvas uppers. Tournament regulations specify the following:

> In all tournaments and matches sanctioned by the National Association the use of spikes is prohibited unless the Referee shall

> determine that grounds conditions justify their use. The use of spikes longer than 3/8 of an inch is prohibited under any circumstances. In all such tournaments or matches played on any surface other than grass, heel-less flat-soled shoes must be worn.[6]

The rubber soles absorb much of the shock of running and the canvas top is light and comfortable. These qualities are greatly to be desired when it is remembered that a tennis match may last several hours and the player who tires first is under a definite handicap. Shoe size must be large enough to fit comfortably over heavy wool socks. When a player becomes warm his feet perspire and may swell. Shoes should be large enough to allow for this expansion.

Care and Repair

The following are suggestions for care and repair of the ball, net, and racket.

Ball

1. Brush off dirt and dust before balls are put away.
2. If wet, allow balls to dry out before they are put away.
3. Store at a normal room temperature, away from extremes in heat or cold.
4. Replace balls that become damp during play. Dampness is particularly harmful to gut stringing.

Net

1. Take twine nets indoors when the weather is damp or wet. Ideally, do this every night in those sections of the country that are very humid and damp, or where there is a heavy dew.
2. Slacken the rope cables at the end of each day.
3. Check nets regularly for holes, tears and other damage, and repair them immediately. A fisherman's knot can be used for repairing broken threads.
4. During very dry seasons and at the end of a season, wash nets with a hose to remove dust and dirt. This is done with the net in place on the court.
5. Be sure that nets are thoroughly dry before storing them at the end of the season. A cool, dry place protected from rodents is recommended.
6. Dip cord nets into commercial creosote once during the season and before storing.

6 *The Official Tennis Guide and Yearbook, op. cit.*, p. 185.

7. Wipe the steel cable occasionally with an oily rag, and remove rust with emery cloth dipped in kerosene.

8. Replace worn canvas bindings with new ones that can be purchased in sporting goods stores or direct from the manufacturer.

9. Occasionally wipe metal nets with an oily rag.

10. Replace worn net bindings and steel cables on metal nets. These items can be purchased separately.

Rackets

Particular care should be given to both wood and metal rackets to insure a long life.

WOOD.

1. Expose the racket to the air a few minutes before playing outdoors to allow frame and strings (gut) to reach equilibrium.

2. Place the racket on a level, dry surface during rest periods. Damp or wet surfaces are harmful, especially to the stringing.

3. Pick up balls by a method that does not necessitate pulling the racket over and under the ball. Scraping the racket along the ground wears down the wood and weakens the frame.

4. Do not use the racket to hit at other objects and surfaces. This damages the stringing and wood and spoils the appearance of the racket. The racket is constructed to hit balls only.

5. Wipe off the racket grip and wood frame before putting it away. Use a cloth dampened with a mild soap and water solution. Avoid touching the stringing if it is gut. Then use a dry cloth to wipe off the gut strings and the wood. Rackets are dampened by moisture in the air, or perspiration from hands, or both.

6. Keep the racket in a waterproof case, preferably one lined with a moisture-absorbing material. Chamois makes an excellent covering. If a racket cover is not available, newspapers serve a similar purpose, especially in damp weather.

7. Put the covered racket in a press, keeping the top of the frame flush with or below the level of the top of the press. Tighten screws evenly at each corner. Some presses close by means of a clamp that exerts equal pressure on all parts of the frame. Place the racket and press on a flat surface protected from the pressure of other objects. The ideal room temperature is about 70 to 75 degrees, and 50 to 60 per cent humidity. Constant temperature and humidity are advisable. Avoid extremes of heat and moisture.

8. An alternate method of storage is to suspend the racket from pegs or brackets on the wall. The racket is supported at the throat,

with racket frame above the supports. It is harmful to a racket to hang it on a nail or peg.

9. Apply a thin coat of shellac (transparent) to gut strings to protect them from humidity and fraying.

10. Apply wax to the wood frame occasionally to preserve the wood.

11. Return a damaged frame that can be repaired to the manufacturer. However, a break in the frame cannot be repaired satisfactorily. Few repairs can be made by the inexperienced.

12. Have broken strings repaired at the local sporting goods store. If such service is not available, the store will send the racket to the manufacturer for restringing. It is not necesssary to have the entire stringing replaced since repair of only the broken strings can be made.

13. When the finish on the wood begins to wear off rub the frame with fine sandpaper until it is smooth and even, and then varnish it. The frequency of this operation depends on the amount of use to which the racket is put.

METAL.

1. Occasionally wipe the frame and strings with any good cleaner (wax base) to prevent rusting.

2. Insert oil in each hole in the racket head, and swing the racket back and forth several times. This will help the oil to penetrate through the hole. (Copper-plated strings will not rust.)

3. Racket heads or shafts that break may be welded, but are not too satisfactory except for class practice. Local machine shops may handle this type of repair. For a more expert job, return the racket to the manufacturer, after contacting the company to see if repairs of this nature are made.

BADMINTON

Badminton in the United States is one of the more recent games, but in the history of world sports it is comparatively old. The game originated in India and was first known as Poona, probably after a city by that name in southwest India. The game was introduced into England about 1870 by returning servicemen. It took its present name from the village of Badminton, the residence of the Duke of Beaufort, an early enthusiast of the game. Badminton spread to Canada about 1890 and into the United States a few years later. Woolen balls with feathers attached have been replaced by cork and rubber tip shuttlecocks. Present day rackets with their slender, well-

balanced frames and fine stringing bear little resemblance to the old wooden bats used formerly. Badminton has spread rapidly in the United States since 1929, and badminton clubs have been organized in many of the larger urban areas. Many schools and colleges have added the sport to intramural and recreation programs.

The game is played both indoors and outdoors, which necessitates the use of shuttlecocks that differ in construction and weight for each of these playing areas, since provision must be made for wind resistance outdoors.

Equipment[7]

Racket	Racket press
Shuttlecock (bird)	Racket cover
Humidifier	Practice ball
Net	Costume
	(See pages 204–206)

Racket

The shuttlecock can travel at such high speed over a comparatively small area that rackets must be light and fast with a minimum of wind resistance. The handle must have excellent flexibility or whip in order to impart the necessary speed to the bird. The sensitive touch needed in many shots, such as drop shots and short serves, places a premium upon good racket balance (see Figure 60).

FRAME. As in tennis, top quality wood rackets are made of well-seasoned, second growth ash. Good rackets may also be made of maple. Laminations are smaller than those in a tennis racket and fewer in number. About five to six laminations are considered sufficient for top performance and durability. Fiber or hardwood (sometimes cherry) may be combined with ash or maple to form the laminations. Overlays on the throat and shoulder may be of birch or fiber. Wood shafts and throat may be reinforced with fiber strips or bamboo in the better rackets. Steel shafts are popular with some players. They are stronger than wood, and it is claimed that they offer less wind resistance. Medium quality rackets may have a vellum wrapping on the shoulders and throat instead of an overlay. Rackets of minimum quality are painted and have some trimming, but are not reinforced with an overlay. The best grip is calfskin, preferably perforated. Suede leather may be used on less select rackets.

Some of the specifications for badminton rackets drawn up by the Quartermaster Corps will give an indication of the factors that are

[7] See Tennis Equipment, pp. 188–206 for additional information.

considered essential to durable, attractive and efficient rackets. According to these specifications, laminated rackets must have not less than three plies with additional plies of vulcanized fiber approximately 1/100 inch thickness permissible. If a weight is inserted in the hole of the handle it shall not loosen in nominal play. If a dowel type of joint unites the handle and shaft, they shall fit snugly and be

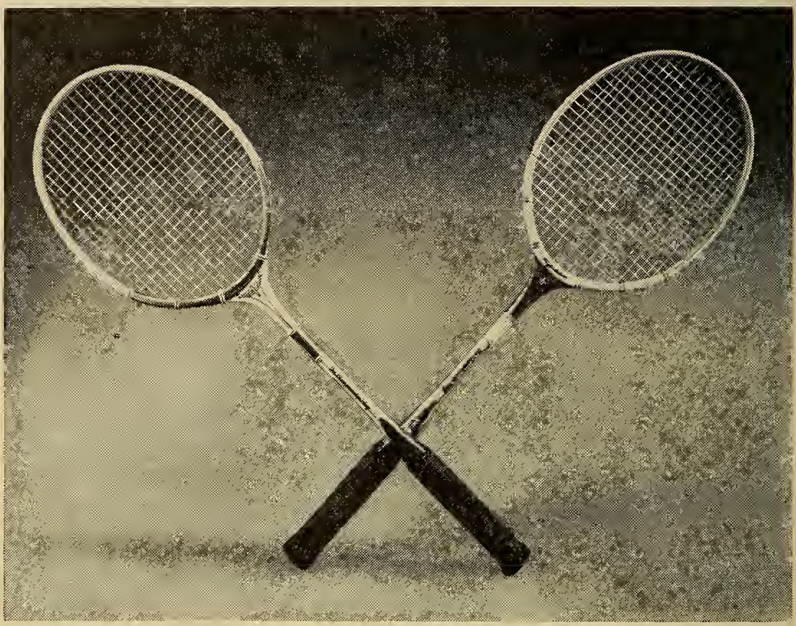

Figure 60. Badminton rackets. (*Courtesy of A. G. Spalding and Bros., Inc.*)

firmly bonded. Holes for stringing shall be accurately and neatly drilled. The holes at the top of the handle on the outside of the frame shall be joined by slots just deep enough and wide enough to bury the strings, and the edges of these slots shall be rounded off to minimize breakage of the string. The grip shall be approximately 3 7/8 inches and the leather winding shall be not less than 5½ inches. Exposed parts of the wood frame shall be sanded smooth and suitably filled before the lacquer is applied. The racket shall weigh not more than 6 ounces.[8]

Steel rackets strung with steel or copper plated stringing are never

[8] United States Office of Quartermaster General, *Rackets, Badminton, With Press,* September 12, 1946, pp. 2–4.

used in tournament competition, but have proved very durable and satisfactory for general school use. However, the steel strings cut into the bird and shorten its playing life considerably. These rackets cost about the same as a medium-priced wood racket.

The same size and weight rackets are used by men and women, with the exception of possible variations in grip size. Women may prefer a 3⅞ inch grip. Racket dimensions and weight are indicated in Table 14.

Table 14

MEASUREMENTS FOR BADMINTON RACKETS

Weight	*Width*	*Length*		*Grip*	
	Head	*Frame*	*Head*	*Circumference*	*Length*
5-6 oz.	7″ (App.)	27″	9¾″ (App.)	3⅞″ 4″	6″

STRINGING. The small light frames of badminton rackets cannot stand a heavy stringing that is too tight, since this would draw the bow out of shape and pull the main strings out of line with the shaft. Tensions from 15 to 20 pounds have been found satisfactory. A 19 to 20 gauge gut is used in most rackets. See pages 200–203 for a discussion of kinds of stringing used in rackets.

Net

According to the official rules of the American Badminton Association:

> The net shall be made of fine tarred cord of ¾ inch mesh. It shall be firmly stretched from post to post and shall be 2 feet 6 inches in depth. The top of the net shall be 5 feet in height from the floor at the center, and 5 feet 1 inch at the post, and shall be edged with a 3 inch white tape doubled and supported by a cord or cable run through the tape and strained over and flush with the top of the posts.[9]

Nets range from 18 feet to 22 feet in length and from 2 to 2½ feet in width. For tournament play the net must conform to official specifications. For all courts on which the posts are placed on the side boundary lines nets that fit exact court dimensions (singles or doubles) and have top and bottom tie cords that extend 3 to 4 feet from the corners of the net are preferable to nets that are larger than

[9] "Laws of Badminton," *Official Tennis-Badminton Guide,* 1950–52, p. 34.

court size. Otherwise, the net will have to be wrapped around the post. This is particularly undesirable when several courts are side by side and the same post must serve two courts. Meshes should be constructed of a heavy-weight twine (at least three-ply thread). A cotton thread 24/4 or better is recommended for use as netting and a #48 twine for bottom tie cords. These should extend 4 inches in length from corners of net.

Longer, wider nets cost more than nets of smaller dimension. Quality of the cord also affects the price. This is true also of the size of the mesh; the smaller the mesh, the higher the cost, other factors being equal. Grommets or eyelets are put on the more expensive net bindings, and the binding is stronger, more closely woven and of a heavier fabric.

Shuttlecock

For top quality birds, feathers are carefully graded and only the best goose feathers are used. Very inexpensive birds are made with white chicken feathers. Feathers are carefully shaped, either rounded or pointed, and inserted into a cork base for indoor, and some outdoor, birds. There are sixteen feathers in top quality birds. Outdoor birds may have a rubber- or latex-coated base. A stitchless outdoor bird with a thermoplastic base has been introduced recently. It is claimed that this bird will outlast two or three regular shuttlecocks (see Figure 61). The best birds are held in place with three rows of stitching, and the spines of the quills are straight. The base of the indoor bird is covered with white kid and banded at the top with colored scotch tape. Birds may be secured in three different flights—standard, fast and outdoor. For beginners and ordinary practice play a standard flight is recommended. Expert players use fast flight. Standard weight for indoor birds is 79 grains. Outdoor birds are weighted for greater speed needed when playing in the wind. As a makeshift substitute for outdoor birds a cut can be made in the base of the indoor bird and a screw inserted for weight. Outdoor birds range in weight from 100 to 130 grains, depending on the composition of the base.

Birds are sold individually, three in a box, twelve in a box (usually including a humidifier tube), and by the gross. There is a considerable reduction in the cost of shuttlecocks if they are ordered by the gross.

Shuttlecocks must conform to certain specifications described in the official rules. These include the following:

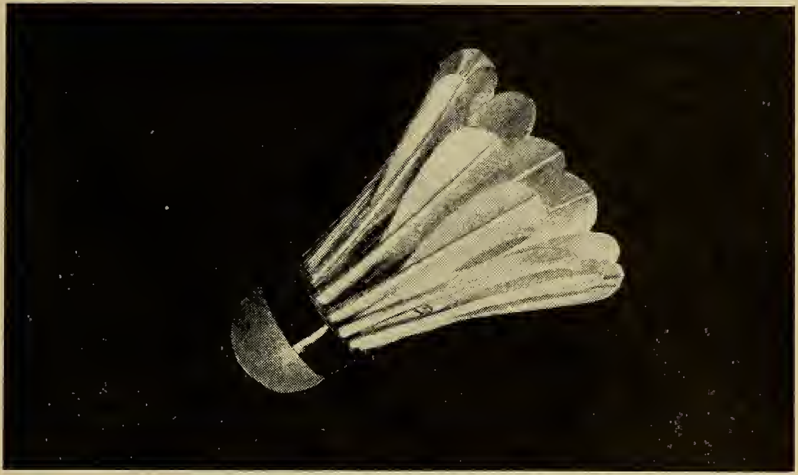

Figure 61. Stitchless outdoor shuttlecock with thermoplastic base. (*Courtesy of General Sportcraft Company, Ltd.*)

A shuttle shall weigh from 73 to 85 grains, and shall have from 14 to 16 feathers fixed in a cork, 1 inch to 1⅛ inches in diameter. The feathers shall be from 2½ to 2¾ inches in length from the tip to the top of the cork base. They shall have from 2⅛ to 2½ inches spread at the top and shall be firmly fastened with thread or other suitable material.

In places where atmospheric conditions, due either to altitude or climate, make the standard shuttle unsuitable, the specifications in this Law may be modified, subject to the approval of the National Organization concerned. A shuttle shall be deemed to be of correct pace if, when a player of average strength strikes it with a full underhand stroke from a spot immediately above one back boundary line in a line parallel to the side lines, and at an upward angle, it falls not less than 1 foot, and not more than 2 feet 6 inches, short of the other back boundary line.[10]

Wool Practice Ball

Wool practice balls can serve for practice purposes, especially for beginners. These may be purchased, or made by winding yarn on a card, then tying the yarn tightly in the center and cutting the loops. The yarn can be shaped into a ball and the edges brushed. The card should be approximately 2½ inches in width, and 400 revolutions of yarn will produce a ball of suitable size.

[10] *Ibid.*, pp. 34, 36.

Humidifier (Humidor)

Various types of humidifiers for shuttlecocks are on the market, including one placed in the top of boxes in which shuttlecocks are sold. The main feature of all humidifiers is the retention of moisture to keep the feathers from drying out. Homemade humidifiers can be constructed with little effort. A homemade variety that has been used successfully consists of a tin can into which is placed a smaller can filled with water. A screen, or piece of perforated cardboard, is put over the smaller can to serve as a base on which the birds rest. The can is then covered. A wet sponge may serve equally well in place of the water-filled can.

Care and Repair

For suggestions concerning care and repair of badminton rackets, see items 1, 2 and 4–13 under Care of Wood Tennis Rackets, pages 207–208, and items 1, 2 and 3 under Care of Metal Tennis Rackets, page 208.

Net

1. Check nets regularly for holes, tears and other damage and repair immediately with string or very strong thread.
2. Fold nets before they are stored, and lay them flat on a smooth surface, protected from dirt and rodents.

Shuttlecock

1. Unless humidified, the quills of feathers dry out and break easily when the bird is hit. Humidify birds three to four hours before using them. Longer exposure to moisture causes the stitching to get too damp and loosen.
2. During play, throw or hit the shuttlecock when it is being returned to a player upon completion of a point. Feathers are damaged if the bird is brushed along the floor with the racket. Smooth the feathers occasionally during play. This can be done just before serving.
3. Store the shuttlecock in an upright position with the base down, so that there is no pressure on the feathers. A wire grill with large enough opening, or cardboard with circular cut-outs to fit the base, can be used for this purpose, if boxes in which the birds are purchased are not available.

4. Remove the bird from the box by the base, not by the feathers, as the latter method will cause the feathers to break.
5. Keep birds off the floor, benches and other places where they could be injured, when they are not in use on the court.
6. Replace a broken feather with a good one, by inserting it through the stitching and cementing it carefully with a minimum amount of cement so as not to destroy the balance.

SQUASH RACQUETS AND SQUASH TENNIS

Squash racquets and squash tennis are two of four games, each of which uses similar equipment but is played under different regulations. The other two, court tennis and racquets, are not discussed here because of the very limited participation in each. The evolution of the name squash racquets stems from two sources. Squash originated from the "squashy" sound caused by the soft hollow ball hitting the wall. Racquets was added because of the similarity of this new game to the sport called racquets.

Until 1922, there were no definite rules of play or regulations governing equipment and playing facilities. In that year the Central Squash Committee was formed in England. In 1923 this committee together with the Tennis and Racquet Association set up standards for the size of balls, rackets and courts. In 1924 a new set of rules was adopted different from those used for racquets, according to which the game had been played previously. Squash tennis was an early deviation of squash racquets and was improvised in an effort to make a faster game. To effect this speed an early devotee of the game, S. J. Feron, substituted a tennis ball and racket for the soft hollow ball of squash racquets. Menke writes:

> Feron was satisfied that this speeded play but he was not able to create the same difficult twists with his rebounds as with the regulation squash ball. He finally put some netting around the tennis ball and this made it possible to execute intricate plays.[11]

Thus it was that two games developed: the one with the soft hollow rubber ball, and the other with an inflated ball, smaller than a tennis ball, with tight webbing over the normal cover. To differentiate between the games, the second and newer game was called squash tennis. Each is played indoors in a small, cell-like room, completely bare of any equipment except a metal plate (or tell-tale) that is placed low on the front wall. Temperature of the room is cool, since players warm up very quickly.

[11] F. G. Menke, *The New Encyclopedia of Sports,* 1947, p. 898.

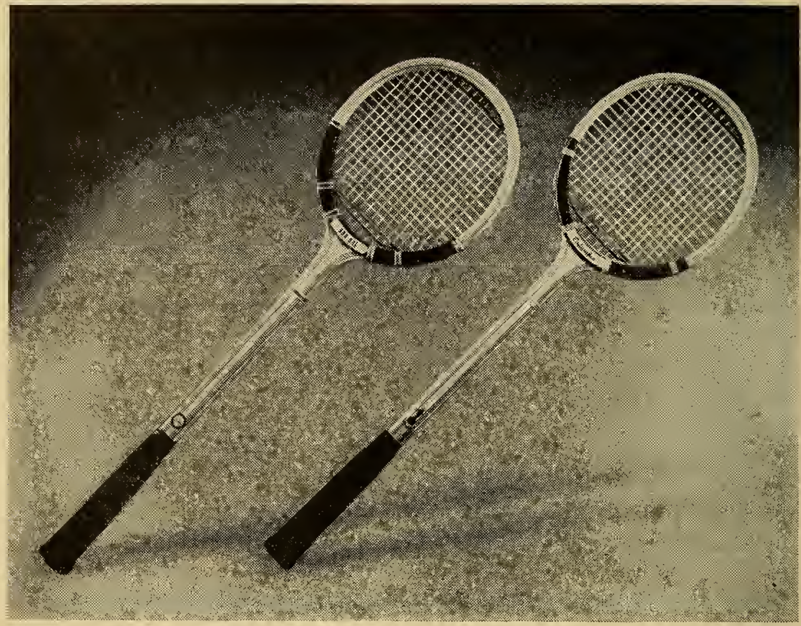

Figure 62. Squash Rackets. (*Courtesy of A. G. Spalding and Bros, Inc.*)

EQUIPMENT[12]

Racket	Racket press
Ball	Racket cover
	Costume
	(See pages 272–298)

Racket

Squash rackets are manufactured along lines similar to those used in constructing tennis rackets, with minor variations (see Figure 62). These rackets are as long as tennis rackets—27 inches—but have a smaller head. According to specifications set up by the United States Squash Racquets Association:

> The racquet or bat shall have a wooden head in the shape of a regular racquets bat except that its entire length shall not exceed twenty-seven inches. It shall be strung with gut or some substitute provided it is not metal.[13]

[12] See Tennis Equipment, pp. 188–206.

[13] *The Official Guide of the United States Squash Racquets Association,* 1948, p. 25.

Racket heads are nearly round, smaller than tennis rackets (about 8 inches wide measured to outside edges of the bow), and have an average of six laminations. Racket weight for men is 8 to 10½ ounces; women usually use an 8 ounce racket. Shoulder overlays may be used on the face of the racket but are not placed on the sides. A 6 to 8 inch calfskin grip covers the handle. Rackets are strung with a #15 gauge gut, or with nylon, 15 or 16 gauge, .052 to .057 in diameter.

Squash tennis rackets are similar to those used for tennis, except that they are slightly smaller, one inch shorter and one to two ounces lighter.

Ball

Balls for squash racquets singles and doubles differ slightly. Each is made of black rubber, 1¾ inches in diameter, but a faster ball is used in doubles. The official rules of the Squash Racquets Association state:

> The standard doubles ball . . . shall be of rubber 1¾ inches in diameter, weight 1 to 1.06 ounces. It shall be pneumatic and shall have a rebound upon a steel plate at a temperature of 68 degrees Fahrenheit of 36 inches from a drop of 100 inches.

For singles, the specifications are the same except that the ball shall weigh 30 grams and have a rebound upon a steel plate of 32 inches from a drop of 100 inches at a temperature of 70 degrees. A white dot appears on the doubles ball to distinguish it from that used for singles.

The United States Quartermaster Corps has set up specifications for the procurement of squash balls which should be of help to any purchaser of squash equipment. Detailed requirements include the following:

> *Construction*—The ball shall be of the plugless variety, consisting of a two-piece vulcanized rubber shell.
>
> *Finish*—The ball shall be well-trimmed and buffed so that the seam is inconspicuous. The ball shall have a smooth finish and shall have a durable soilproofing treatment, which shall no more than slightly blacken a white enameled board when rubbed against it . . .[14]

Squash tennis balls are the same as those used in tennis except that they are dyed green in color.

[14] United States Office of Quartermaster General, *Balls, Squash (Racquets)*, February 1, 1945, p. 2.

Table 15

SQUASH BALL DIMENSIONS[15]

	Diameter (Inches)	*Weight (Ounces)*	*Out-of-Round (Inches)*	*Rebound (Inches)*	*Compression (Inches)*
Type I	1.73-1.77	1.10-1.25	0.020	28-33	0.140-0.170
Type II	1.73-1.77	1.10-1.25	0.020	35-39	0.140-0.170

CARE AND REPAIR

Methods of care and repair of the racket are discussed under Care of Wood Tennis Rackets, items 2–13, pages 207–208. With regard to the squash racket, wash it after play in a mild soap and water solution to remove dirt and perspiration. Store balls in a cool dry place.

15 *Ibid.*

CHAPTER XIII

Skiing

Skiing is believed to have originated in the Altai Mountains of central Asia and was introduced to Central Europe by the Norwegians. For many centuries it was used solely as a means of transportation in the lands of heavy snow. Not until about 1920 were the possibilities of winter playgrounds and skiing as a recreational sport realized. Although skiing has been enjoyed to some extent in the United States since 1900, it took the 1932 winter Olympics at Lake Placid to impress the general public with the potentialities of skiing as a sport. It is estimated that there were 5,000,000 ski enthusiasts in 1949. New England alone has 1500 miles of specially designed and constructed ski trails, and other areas of the country are following close behind. The upward trend has received additional boosts by military training and the recent Olympics. It should not be too long until ski terms such as christies, and schusses are familiar words in the American vocabulary and the cry of *track* as common to the rolling terrain as *fore* now is on the golf course. Many colleges and universities include ski instruction as part of the physical education curriculum. In areas where snow is scarce, courses in dry skiing are offered on a straw base.

EQUIPMENT

Skis	Costume
Bindings	shirt and sweater
Poles	jacket
Waxes	pants
	hose
	mittens and gloves
	headgear
	boots

Be sure that the equipment is adequate. It need not be expensive, but it must fit properly. From the standpoint of safety good ski equipment will always pay for itself many times over. Thus ski equipment should be chosen on the basis of service rather than eye appeal.

Boots, skis, bindings, poles, waxes and suitable clothing are the essential items for the skier. However, depending upon the pocketbook, there are endless accessories. These include such items as special rubbing corks for wax applications, racks for carrying skis on a car, sealskins to aid in climbing, sun visors, sunglasses, face masks, repair kits, first aid kits, sleeping bags, after-skiing slippers, sunburn lotion, and so on. This section on skiing has covered only those pieces of equipment thought to be essential.

Skis

A rather wide variety of skis is available to the consumer. Variations in materials, size and design must be considered in terms of personal preference, locale, end use and other factors that govern intelligent selection. All good skis must, however, meet standards of strength, flexibility, shock resistance, resistance to warping and hardness requisite for the demands made upon them.

TYPES. There are two main types of skis—wood and aluminum.

Wood. A wide range in prices of wooden skis will be noted in the ski market. Difference in cost is reflected in the quality of wood. Ninety per cent of the solid skis sold almost any season for cross-country or downhill running are of hickory. The following species of true hickory are the most acceptable: mockernut (hicoria alba), pignut (hicoria glabra), shagbark (hicoria ovata) and shellbark (hicoria liciniosa). Ash is considered to be the second best wood for skis. When compared to ash, hickory has a 25 per cent greater compression strength, 20 per cent greater bending strength, 75 per cent more shock resistance, and is 40 per cent harder. High grade ash and birch are excellent for touring skis and are used extensively in Europe.

Maple is much less desirable than hickory but is satisfactory for the occasional skier who stays on very gradual slopes.

In recent years laminated skis have come into existence. They are more flexible than solid skis and have withstood severe tests, so that this type of ski is extremely popular (see Figure 63). Laminated skis consist of a top section, bottom section and center section. The wood for the top and bottom sections should be true hickory and have the same sloping grain and mineral streak specifications as solid hickory skis. One type of laminated ski is constructed so that the top and bottom sections have not less than three, and usually more, longitudinally jointless, paralleled-edge-glued pieces arranged so

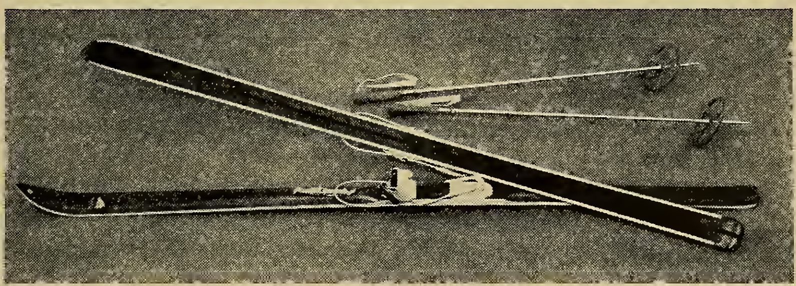

Figure 63. Laminated skis with bindings and steel edges and metal climbing poles with welded steel tips. (*Courtesy of A. G. Spalding and Bros., Inc.*)

that corresponding pieces of the top and bottom sections are balanced. A second type is built with each of the top and bottom sections in a single piece of wood; and in this case both pieces should be of the same grain, either flat or edge. A third type of laminated ski has the top and bottom section each consisting of two continuous pieces of equal thickness. Each of the four pieces should be in balance with the other three. All three types of laminated skis must have a center section. It should extend at least from the thin part of the ski tip to the thin point of the heel. In some skis it runs the full length. Along with hickory, white ash, yellow birch and sugar maple are sometimes used for center sections. True hickory wood is the most desirable. Laminated skis without a center section are acceptable, provided the top section consists of not less than five longitudinally jointless pieces arranged so that they balance on each side of the center line. The bottom section should consist of three or more continuous pieces arranged in the same manner.

Wooden skis require considerable care, including waxing, to pre-

vent them from warping and to prepare them for contact with various types of snows. This problem has been largely instrumental in promoting the popularity of the second type of ski—aluminum.

Aluminum. The first aluminum ski was used in 1934, and during World War II the United States Army did considerable research on aluminum skis for its mountain troops. As yet, there are very few aluminum skis on the market, and not too much is known about them.

The ability of any type of ski to slip easily over snow and ice depends primarily on the formation of a thin layer of water which acts as a lubricant between the ski and the snow. Its formation is due to the heat generated by the friction of the moving ski and also due to the weight of the skier. Another factor is the thermal conductivity of the material. It is this factor that determines how much of the heat is dissipated and how much remains to maintain the lubricating layer of water. It is claimed that the all-metal ski satisfies the above requirements.

In contrast to the use of waxes on wooden skis, exponents of aluminum skis point out that little or no preparation is needed for metal and that there is no danger of the skis becoming waterlogged or warped. Expert skiers have testified that at temperatures of 25 to 32 degrees, untreated aluminum skis are at least as good as the most efficiently treated wooden ones. At lower temperatures and also for climbing, some surface treatment is needed.

SELECTION. When purchasing the lowest-priced ski, a person can often expect to be offered the castoffs of all the higher grades. The hickory used in the construction of these skis will have cost the manufacturer the same price by the carload as the wood for his most expensive skis. After continued selecting and grading of the carload lot, the lower-priced ski is made of the wood that is left. The models in most cases are the same, and they will have stained bottoms to cover slight imperfections such as sap stains or small knots.

The second grade up the scale will have clear bottoms or what is termed a fair finish. The model just above the fair finish is probably sold as a very good ski, while at the top in quality are the ultra deluxe of the factory, often known as "super" or specially selected hickory skis.

General. When selecting a pair of skis place each ski on a flat surface and press it gently from side to side. If it rocks, the ski is warped. When skiing, a warped ski will turn in its own direction and not in the direction wanted by the skier. The points of skis should be

resilient; if not, they will break easily when the curve touches an object.

When purchasing wooden skis, the question always arises as to the grain of the wood. A pair of skis may be equally as good and give equal service whether they be edge-grain or flat grain hickory. Those who favor the cross grain or edge grain believe that this ski is more elastic and has greater resistance to warping. More important is the slope of the grain. On any ski, from the tip end of the ski to a point 36 inches from the tip, the slope should not exceed one inch in 15 inches. From about 36 inches and extending to the back of the ski, the slope of the grain may be as much as one inch in 10. Skis made of hickory which have mineral streaks more than 1/32 inch wide or more than 12 inches long are not recommended.

As was discussed earlier hickory skis are tough and durable and thus far have proven best. Ash, birch, maple and pine skis are less expensive and less practical. Their greatest value is in their lightness, an important item in cross-country skiing. Ash and birch, in addition to being light, are fair in qualities of strength, but as the wood is softer, ski edges (without steel plates) may be worn away in one long mountain trip, especially if the snow is hard and icy. Many ski instructors believe that it is best for women and all beginners to use light skis since they are easier to handle.

In selecting skis for the correct length for general use in all snow conditions and on all slopes, it is best to obtain skis whose tips reach the palm of the hand when arms are outstretched above the head. This is especially true for general touring or downhill and slalom skiing. If there is any doubt as to the locale of the skiing or the condition of the snow, tend toward a shorter ski. Under many conditions, a person who might reach to a 7¼ foot ski would be better suited to a ski 3 to 6 inches shorter.

Heavy persons should have stiffer, stronger skis since a definite sag at the center of the ski will make climbing harder and sliding slower. Double- and triple-groove skis should be used for jumping only, since more than one groove makes turning difficult. Stiff skis are excellent for racing on smooth snow, but a more flexible ski is preferable for the average trails and slopes and for beginners.

Steel edges for all running skis are highly recommended. Because of the serious damage done to the one-piece, screwless type of edge when the ski strikes a partially hidden stone, metal strip edges are suggested. Steel edges should be fastened on with screws and neither of the end screws should be more than ¼ inch from each end of each section. Edges are available in sections from 7 to 12½ inches long—10 to 12 inches usually considered the best length. Steel edges

should extend to within approximately 3 inches of the ski tip and about 1½ inch from the heel. Good steel edges are between 2/5 and ½ inch in width and 5/16 inch thick. The narrowest available edges (but not under 2/5 inch) should be chosen since they offer less resistance. Rustproof steel is the best material, and sharpness of the cutting edge is important. After the edges are secured to the ski there should be no screw points visible on the top surface nor should there be any projecting screw heads above the steel strips. Repair is easy when one section has been damaged. Usually only good grade hickory and laminated skis are worth the additional cost of steel edges.

The groove in the bottom should be not less than ⅜ inch nor more than ½ inch wide, between 5/64 and 7/64 inch deep and should not deviate more than 1/16 inch from the center of the ski.

In addition to fitting for the proper length, the skis should also have the proper camber (the arch or curvature of the ski under the binding which flattens out when the skier stands up). Too strong a camber will cause the ski to remain elevated while the two ends dig into the ground. A camber that is too weak will cause the middle to sag and elevate both ends of the ski. The normal camber is ½ inch on a flat surface and should never exceed one inch.

Special. Cross-country skis are longer, lighter in weight and narrower, usually 2 to 2½ inches wide. Laminated skis have found wide acceptance in cross-country skiing since a very light wood can be used for the center section, thus making a ski just half as heavy as a solid hickory but with almost an equal stability. There is some difference of opinion as to the durability of laminated skis when compared to solid skis. Ski instructors recommend laminated skis to cross-country runners with a good sense of balance. For cross-country courses through large wooded areas many persons prefer to use skis that are shorter than usual. Where the terrain is flat open country and where cross-country touring is the main form of skiing longer skis, 7¼ to 7½ feet, may be needed. Especially is this true if the snow is light and powdery.

For jumping, heavier skis between 15 and 18 pounds should be selected. The ski weight varies with the weight of the jumper. Until very recently solid hickory skis were always used for jumping, but laminated skis are now being used by some jumpers. By varying the wood of the center section, stability, flexibility and weight can be controlled. A laminated ski of nonelastic wood will not spring unduly on a hard landing course. Jumping skis should always have two or three grooves in the bottom. Grooves running the full length of the ski give added control needed for jumping.

Binding

Almost as important as the skis are the bindings. Their purpose is to hold the boot firmly to the skis during any type of skiing action. In selecting bindings be sure there are toe irons which secure the forepart of the foot in place, a toe strap which holds the boot in the toe iron, and a steel (covered or uncovered) cable around the entire assembly which is snapped into place by a forward throwing lever. Metal bindings are more expensive but much safer and give far better ski control than do leather bindings. Wet leather becomes too flexible. The steel cable may or may not have a steel spring to fit over the boot heel. It is a better binding if it does. The toe irons should be long enough to prevent the boot from slipping sideways and should allow for adjustments to as close as 1/16 inch.

The downward force of the binding onto the boot depends upon the type and strength of the boot soles. The better the boot and the stronger the sole, the less downward pull that is needed. The average pull is one that allows the skier to raise his heel from one inch to 1½ inches when the cable is in the last notch to the rear. This fit is used in slalom. For downhill skiing there must be more foot elevation and the cable should be fastened in the first notch. Close attention should be paid to the mounting and adjustment of the plates and harnesses. Adjusting bindings for jumping varies for most people. For the good jumper the ski normally hangs balanced from the toe strap. The contracting force of the binding must be sufficient to hold the heel of the boot firmly against the ski and yet not cause the ski tips to point upward.

Poles

Poles may be either bamboo or metal, and the lighter the better provided the strength is the same. Metal poles are better (see Figure 63).

If bamboo, the laminated split cane shaft should have no joints and should be of a choice quality, heavy-walled tonkin cane. The laminations should be glued together with a water-resistant type of glue. If heavy moisture causes the laminations to separate, the glue has failed. The shaft should be not less than ½ inch in diameter at its smallest point, and should increase ⅛ inch in size toward the grip in 36 inches. The snow ring should be at least 6 inches on inside diameter, ½ inch wide and ¼ inch thick. The rings should be white ash or hickory strips and wrapped so as to form four laminations, then glued with water-resistant glue. A forged steel point with approximately a 30 degree curve should be fastened securely to the

cane shaft. It is important that the point does not rotate. The curved point helps to prevent breaking. The snow ring should be between 3 inches and 4½ inches from the tip of the steel point.

If the pole is metal, it may be aluminum or steel. Steel is usually preferred. A steel pole should have a tapered steel tube for a shaft and should be not less than 2/5 inch nor more than ½ inch in diameter at its smallest point. It should taper approximately ⅛ inch in 36 inches as it approaches the top. A curved, forged steel point should be securely spot welded to the shaft, and the snow ring should be fastened from 3 to 4½ inches from the steel point. The ring should have an inside diameter of at least 6 inches. Full-grain leather straps (usually six) are preferred as spokes for the ring.

The height of the snow ring from the ground is a matter of local conditions and personal choice. For the average ski enthusiast, 3 inches might suffice while someone vitally interested in the slalom might prefer the ring 4 to 4½ inches from the ground.

For both tonkin and metal poles the grips should be of good quality chrome leather, soft and pliable with the grain side out. All stitching should be with a suitable thread and strong enough to leave a flat and smooth seam with no ridges. The wrist straps should be approximately ⅞ inch wide at the center and taper slightly toward the ends. It is important that the riveting be secure. The wrist strap should provide a wrist opening of between 7½ inches to 9 inches, and it should fit the wrist snugly without cutting.

When selecting an all-duty ski pole for size, select one that reaches to the armpit when standing on the floor. If most of the skiing is to be done on slopes where tows and lifts are used, ski instructors suggest a pole that reaches 4 or 5 inches above the hip. For the person who may do a great deal of climbing an adjustable pole is available.

Wax

There are many varieties of wax available. For those just beginning to ski a lacquer will offer the easiest solution. Also available are plastic and permanent bases which will stand up for a considerable period. For techniques and general rules for waxing skis, see pages 232–234.

Costume

The active skier is concerned with clothing that is primarily functional. This does not preclude the wearing of a costume that is both efficient and attractive, but does relegate to the spectator type of

skier all frills and decorative features that detract from freedom of movement and comfort. It is important to keep this fact in mind when choosing an outfit, since the rapid growth in interest in skiing has resulted in the design and manufacture of clothing that serves either spectator or participant but is not readily adaptable to the needs of both (see Figure 64). Functional ski wear must provide (1) warmth without bulk or heaviness; (2) protection from dampness, water, snow and wind; (3) freedom of action, especially across the shoulders, hips, and for arm and leg flexion. Outer garments should be easily removable when the skier feels the need to do so.

Ski outfits consist of shirt, sweater, jacket, pants, socks and boots, as well as long underwear worn under the pants. Mittens or gloves, caps and sunglasses are necessary adjuncts. The jacket and pants may be different materials and colors, in which case they are called separates, or they may be the same. This latter style is termed a ski suit (see Figure 64). A greater variety of costumes to suit mood and weather conditions is possible with separates. Light woolen or cotton underwear that absorbs perspiration and keeps the body from chilling is worn under the shirt and pants. It should be remembered that several thin layers of clothing are warmer than one thick layer since the air between the layers acts as an insulator.

Closely woven and durable fabrics are used in ski wear. These include poplin (usually a 2 x 2 cotton), Byrd cloth, nylon, and gabardine (usually worsted). A combination fabric of 72 per cent wool and 28 per cent cotton has proven especially serviceable. Wool and rayon, and wool and cotton combinations are also used. All outer garments should be water repellent. Waterproof materials do not allow for proper evaporation of body moisture. Very bright colors or dark shades that show up against the white background are popular. Norwegian motifs are widely used in sweaters.

SHIRT AND SWEATER. If the weather is cold, the shirt will probably be wool and the sweater a closely knit, heavyweight wool (see Figure 64). In warmer temperatures a cotton jersey and a lightweight, more open weave sweater may be preferred. Shirts should be full cut to allow freedom of action across the shoulders. A tuck-in style shirt worn under the pants for protection against cold and wet is preferable (see Figure 64). Shirt tails should be long enough to remain under the pants throughout the activity. Water-repellent shirts are advisable if the jacket is to be removed or is not needed.

JACKET. Jackets, like shirts, should have freedom of movement across the shoulders. Armholes should be low cut to allow action and

to provide warmth by not restricting circulation. The jacket must be large enough to fit over shirts and sweaters, and should be tried on over these garments when it is being purchased. A snug fit at neckline, sleeve openings and waistline is needed to prevent the entry of snow. Inserts (gussets) at the cuff opening serve the same purpose. Jackets that have an elasticized or drawstring waistline can be worn inside or out. Sleeves must be long enough and have ample fullness to fit comfortably when the arms are flexed. Jackets should be unlined since lined jackets are too bulky and warm. Jackets that have a zip-in lining can be worn without the lining for skiing and with the lining after skiing when extra warmth may be needed. Pockets may be buttoned or closed with a slide fastener. This latter type of closing keeps out the snow but the fastener should be covered or it may freeze shut. Such fastenings are easier than buttons to manipulate when hands are cold, and can be opened and closed quicker. A scarf worn under the jacket adds further protection and a decorative note to the costume.

A parka is a ski jacket with a hood. The hood may or may not be attached to the jacket. The parka is fitted and has a front opening. The anorak jacket is full and unfitted, has an attached hood and a drawstring closing at neckline and waist. It is usually pullover in style, but may have a full-length front closing. Women who do not wish to disarrange their hair, or who prefer to buy separate hoods, may not like an anorak. However, the protection of the neck from snow due to the attachment of the hood to the jacket is a distinct feature of this jacket. Most anoraks have two large pockets (see Figure 64).

PANTS. Pants should be cut so that there is sufficient fullness across the hips and at the knee for flexion, without detracting from style (see Figure 64). A smooth fit at the ankle is also essential. Careful tapering achieves these objectives and keeps the pants from riding up under the boots. Pants should be at least ankle length. Styling that eliminates a slit at the bottom of the pants leg also aids in keeping the pants under the boot and prevents the entry of snow. The high cut waistline as distinguished from one that has a separate waistband permits a smoother fit at this section of the garment and facilitates the tapering of the pants.

HOSE. Usually a skier wears two pairs of wool socks—one lightweight and worn next to the skin, the other of heavier wool. The first pair may be cotton, especially if the skier is allergic to wool. Socks should fit snugly at instep and ankle but should have sufficient

Figure 64. Clothes for skiing: (a) ski suits, (b) anoraks (father and son), (c) companion ski shirts, (d) ski sweater and helmet. *(a, b, c,—Courtesy of White Stag Manufacturing Company; d—Courtesy of Gretta Plattry Sportswear.)*

room in which to curl the toes. This facilitates circulation and resultant warmth. Many skiers prefer to wear socks under the pants rather than turned over the boot tops since this keeps out the snow.

MITTENS AND GLOVES. Mittens or gloves protect the hands. Preference for either style is purely personal. Some skiers claim that gloves do not permit freedom of movement or provide as much warmth as mittens. Regardless of style, a warm inner pair is desirable, covered by an outer shell that is water repellent and windproof. Wool, nylon and cotton poplin are popular fabrics for these purposes. The long gauntlet style that has an elastic wristband or strap at the wrist to keep out snow is very serviceable. Leather on the palm of the outer gloves or mittens withstands the wear and tear from poles and tows. Have an extra set of gloves or mittens, both inner and outer, to allow for drying out of the first set.

HEADGEAR. A visor type cap protects the eyes from the sun. Some caps have sunglasses attached to the visor but skiers may prefer separate glasses that have ground lenses. Caps with ear flaps or separate ear muffs keep the ears warm. Hoods that fit down under the neck opening or are attached to the jacket are another form of head covering. Men sometimes wear a wool headband for the absorption of perspiration. Wool berets are worn by some skiers.

BOOTS. The leather tops should be firm but not too stiff, and the soles should be thick and absolutely rigid with a built-in piece of steel to prevent buckling in tight bindings. The thicker the sole, the less tiring it is to the foot. Correct fitting is important since the boot is the key to controlled skiing. Speed skiing demands precise control, and snug boots are an assurance that the motions made by the leg and foot are carried through to the skis. In a poorly fitted or faulty boot these motions are lost, because the foot moves inside the boot, or because the leather top is so soft that only the leather upper twists and turns and not the ski. In addition to lack of absolute control, loose fitting boots will allow the foot to slip up and down with each step, thus causing a blister on the Achilles' tendon. Figure 65 illustrates one type of boot.

The new boot should be large enough to accommodate one pair of thin stockings and one pair of heavy wool socks over the foot without having the foot feel cramped. After the boot has been used the leather will stretch a little and a felt or sponge rubber insole should be inserted to take up the extra space. If the boots are so snug that the toes cannot move freely, toes will soon become cold. Until the

boots are properly broken in, they should not be used for a long mountain trip.

The boot should have a square, hard toe because it fits better into the harness. The hard surface gives added protection to the toes. The boot upper should be low enough to fit snugly around the ankle and give adequate support to that area. The heels of the boots should be firmly attached. Downhill skiing requires the skier to lean far forward and the cable bindings exert a strenuous pull and strain on the heel of the boot. A deep groove should start high on the heel and continue almost all the way around, thus allowing the cable bind-

Figure 65. Ski boots. (*Courtesy of A. G. Spalding and Bros., Inc.*)

ing to fit better on the heel. The lacing should reach all the way from near the toes to the top of the boot in order to get a snug and firm fit. Ankle straps are not necessary but sometimes make for a better fit.

The boot upper should be somewhat flexible and should be waterproofed. A double-laced, double tongue construction permits firm lacing with a minimum of discomfort. The uppers of the more expensive boots are partially lined with sponge rubber; the less expensive boots are felt lined. Nickel-plated eyelets are better than brass eyelets because of the corrosion of the latter. Boots with composition soles and heels are not recommended for the skier who expects several years of service; but for children whose boot size may

change every year or two, composition soles and heels are quite adequate. A leather snow shield is preferred to one made of felt. Boots with sponge-filled quarters and snowshield do not require the tight lacing necessary in other types. Ski boots for men and for women in any given model are identical in construction, but the size range varies. For men, most boots can be had in sizes 7 to 12 with some models starting at size 6. For women, the usual range is from 4 to 9. Neither men's nor women's ski boots come in half-sizes. All figures above are for boots made in the United States. Imported boots are usually larger.

Care and Repair

Ski equipment is expensive equipment but its use can be extended over many seasons if proper care is given it. Many ski repairs should be left to the skilled craftsman but others can be done by the owner. Listed below are a few suggestions.

Wooden Skis

Wooden skis as a rule need much more care than those made of metal. In many parts of the United States, skiing is confined to a relatively short period of time but the care of ski equipment spreads over a wider period, including preseason, in season and post season.

PRESEASON. If the skis do not have steel edges, this is the time to have them put on. It is a job for an expert and usually should not be attempted by individual skiers. Preseason maintenance of skis will prolong their usefulness and improve performance. Take off the bindings, use steel wool on any rusty places, and then oil or shellac the parts. Repair or replace any weak parts. If the screws on the bindings do not tighten securely, plug the enlarged hole with a small splinter or match stick; the use of oversized screws will help also. If the skis are without steel edges, restore sharp edges by switching the bindings or planing down the inside edge of each ski.

Revarnish the tops of worn or scratched skis to improve appearance, help prevent cracking and warping, and to keep snow from sticking to the surface. Before revarnishing clean off all the old wax and dirt with turpentine, alcohol or a cleaning solvent. Sand the ski with fine sandpaper (# 0 or 00), and fill the holes and scratches with plastic wood. Apply several coats of spar varnish, allowing each coat to dry thoroughly before applying the next one. Never varnish the bottoms. This is a good time to put a small painted design or monogram somewhere on the top side of the ski to provide means of identification on group trips.

In reconditioning the ski bottoms, there are two possibilities: ski lacquer preparations and base waxing. A good quality ski lacquer is easier to apply and provides an adequate surface for all but the expert skiers. Before applying the lacquer wipe the skis with turpentine or alcohol and sand the bottoms carefully. Be sure there is no wax or oily substance on the surface. Lacquer will not stick over wax or oil. If lacquer base is not used, impregnate wood with linseed oil, pine tar or wax to make it waterproof. Otherwise, the top waxes will wear down and expose the wood. Linseed oil is very easy to use. Brush on coats of hot oil until the wood has absorbed all that it can, and then wipe off the excess and allow skis to dry. Apply a good coat of wear resisting wax.

Use of pine tar and wax necessitates burning the preparation into the wood. Do only one-third of a ski at a time; heat the ski with a blowtorch but be sure to keep the torch moving constantly and do not keep the flame along the edge of the ski for too long. Otherwise, the wood will burn and the edge will warp. Do not work on the curved tip. If pine tar is used, brush on a thin layer; a rag may be used to apply the linseed oil. Then burn the preparation into the wood until small bubbles appear on the surface. Apply the usual base wax and top waxes after the wood treatment. Different types of woods show different reactions to base waxing. Hickory need not be waxed as often as maple, ash or pine. Hickory also absorbs much less wax than the other kinds.

IN SEASON. Care of skis during the winter season is mainly one of surface waxing. Surface waxing is an art, and it can make skiing an enjoyable sport or an unpleasant one. The goal is to make the skis very slippery, and it can never be done beforehand for the type of wax to be used depends upon the condition of the snow, the temperature and the amount of dampness in the air. A ski prepared the wrong way can stick worse than if it had never been waxed, or be so slippery that climbing is virtually impossible.

Surface wax goes on top of the base wax. If possible, leave the skis in a cold place overnight, so that the base wax can freeze. This will prevent the mixing of the layers of surface wax with the base wax. Surface waxes should not be applied until the day of the activity and after all conditions are known. It is almost impossible to describe the exact amounts and kinds of running waxes to be used, but there are a few general rules with which nearly everyone agrees.

For dry snow, apply the wax thin and do not polish it to a high gloss. If the snow is wet, apply a thicker layer and leave the surface rough. Best results in wet snows often come from smoothing the speed wax in with a hot iron. If the snow sticks and the ski does not

slide, there is too much wax or too glossy a finish; if climbing is difficult or impossible, there is not enough wax. Nearly every ski enthusiast, after a few months of skiing, has found his own best wax. Some of the preparations are not the most expensive waxes, but simple home preparations. It is usually easier to apply wax indoors and rub it in with hand or glove. The sticky waxes are put on with a knife or a piece of wood. Getting the back third of the ski too slippery will cause the ski to slide backwards. It is best to allow the skis to reach the temperature of the air before using them.

Any serious damage to the ski itself is usually very difficult or impossible to repair but if the tip of a good pair of skis should break off, save it. The ski can be repaired either by a ski craftsman or by the factory that made the skis.

POST SEASON. Skis should not be stored in a place too dry or too damp or where they are exposed to direct sunlight. Usually a dark, well-ventilated closet is much preferred to a humid basement or a hot, dry attic. They must be protected against moisture absorption, and should be clamped to a suitable form to insure retention of shape. Before storing remove all wax or varnish from top, edges and bottom. When sanding bottom always use a sandpaper block to insure smoothness, and always work with the grain, starting at the tip and going to the heel.

Carefully remove all the sanding dust and dirt, and then apply two coats of waterproof varnish to the top surfaces and two or more coats of transparent varnish to the bottom surfaces and edges, allowing each coat to dry thoroughly. If a pine tar base wax is used instead of a lacquer, linseed oil is an excellent summer coating for ski bottoms. After coating all the metal parts with a thin layer of oil to prevent rust, put the skis into a clamp or a case to maintain their shape.

Steel Edges

Check the steel edges and replace bent or broken sections. Tighten or replace loose or missing screws. Fill each hole with linseed oil before fastening the new screws in place.

Poles

Cane poles should be checked for splits and loose laminations. Only water-resistant glue should be used in regluing. Steel poles need little care. Cover the metal with a thin coat of oil before storing, and oil all the leather parts carefully. An inexpensive replacement for the hand grip is a bicycle handlebar grip. Slip it on

the end of the ski pole and drill a hole through the pole and rubber grip large enough to accommodate the wrist strap. Rivet the two ends of strap together to form the desired size loop.

Boots

Do not use too much oil or grease on the boot, for it will lose its waterproofing. Wax containing polish, applied not more than once or twice a week, is sufficient. For further suggestions for care of leather equipment, see pages 264–266.

CHAPTER XIV

Soccer, Volley Ball, Handball

SOCCER

Prior to the fourteenth century the history of soccer was based to a great extent on the descriptions carried by military groups. It is thought that Roman soldiers introduced the game in England. The early games were varied in rules and organization. Sometimes the goals were as far as 3 to 5 miles apart. Very little is known about the balls used for these games. By 1801 English football, as the game was then called, was played on a field between two goals 80 or 100 yards apart with a ball composed of a blown bladder cased with leather. Recognizing the need for uniform rules, the Football Association was formed in 1863 and today soccer occupies a place in England similar to that of baseball in the United States. In America the first variety of football known was soccer. The first regulation soccer game was played between Princeton and Rutgers in 1869.

Equipment

Ball	Uniform
Shin guards	shorts
	shirt (jersey)
	hose
	shoes

Ball

Soccer balls are manufactured in many types and styles: leather or rubber covers, laced, laceless or molded. A ball advertised as English style is one with a smooth cover but it is made in the United States. An English ball is imported. An American-style soccer ball is one with a pebble-grained cover. The official ball must meet the following requirements:

> The ball shall be spherical; the outer casing shall be of leather and no material shall be used in its construction which might prove dangerous to the players.
>
> The circumference of the ball shall not be more than 28 inches nor less than 27 inches. The weight of the ball at the start of the game shall not be more than 16 ounces nor less than 14 ounces and shall be inflated to a pressure of not less than 12 pounds, and not more than 13 pounds.[1]

Most balls are made in one of two cover designs, twelve panel or eighteen panel; some are laced, others are laceless. The trend recently has been toward the eighteen panel ball even though its cost is from 10 to 30 per cent more than a similar quality twelve panel ball. There is no evidence to show that the performance or durability of a soccer ball rises in proportion to the number of panels used in its construction. On the other hand, the more panels, the greater the number of stitches, and threads are the most vulnerable part of some sewn inflated balls.

When purchasing soccer balls, some consideration should be given to the following types:

LEATHER COVERED. There are two types of leather-covered soccer balls. One has a pebble-grained cover and is sometimes called the football type; the second has a smooth-grained cover and is often called the English type. This latter is not, however, to be confused with the English ball. Tradition perhaps more than anything else has created a somewhat stable market in the United States for balls imported from England. However, a former outstanding English soccer player said, "I do not think there is much difference between the English ball and your ball. In England the balls generally are made of horsehide and it is said that the hides are allowed to stand in the bark tanning solution for a year. Perhaps that accounts for some of the toughness of the cover. The covers are hand sewn with a high quality waxed linen thread."

When selecting or inspecting soccer balls, examine the ball for

[1] *Official Soccer Guide,* 1950, p. 72.

circumference and weight. It should be not less than 27 inches nor more than 28 inches in circumference and not less than 14 ounces nor more than 16 ounces. Take all measurements when the ball is inflated to 12 to 13 pounds of pressure per square inch. The leather panels—cowhide, steerhide, or horsehide—should have no cuts or holes of any size and no loose fibers. If a ball is clearly advertised as a blemished ball, it may have small spots, stains and healed-over

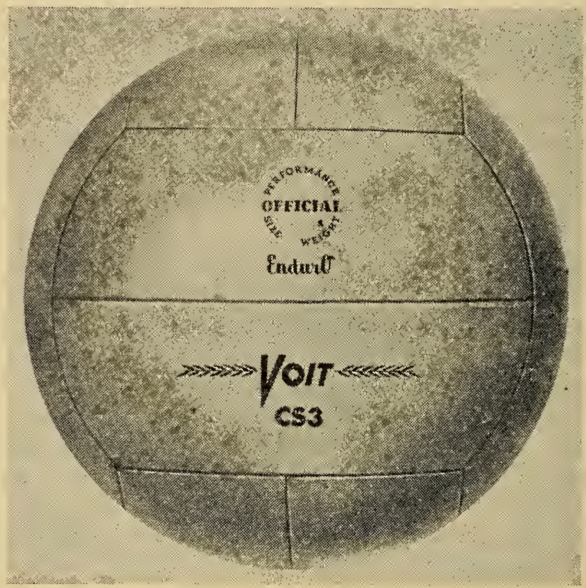

Figure 66. Soccer ball—rubber covered. (*Courtesy of W. J. Voit Rubber Corporation.*)

scars. The seams and stitching must show no needle cuts or chews, no loose threads or open seams, no broken stitches or wrinkled seams. All stitching should be lock-stitched. The finish should not peel, flake or markedly crack when the leather is bent upon itself, grain side out. The lining should be not less than two plies of herringbone twill fabric or its equal. When dropped from a height of 72 inches onto a solid wooden floor, the rebound of the ball should measure 48 to 55 inches.

RUBBER COVERED. It is suggested that when rubber-soled, soft-toed shoes are worn for physical education activities a rubber-covered ball be used (see Figure 66). If a leather soccer ball is not given proper

care or if it is used on a wet field, it tends to become heavy, but this is not true of a rubber-covered ball. Rubber-covered balls should be used when practicing heading.

When selecting a rubber-covered ball, be sure it has a rubber bladder or air retaining lining of three or more ply fabric carcass or a cord-wound carcass. The rubber cover should be vulcanized securely to the carcass. The carcass should be a cotton or rayon fabric or wound cord, bonded together with natural rubber compounds or blends of synthetic and natural rubber. The finished ball should simulate the color and appearance of the official leather-covered ball and should have simulated seams molded into the surface. Whether it is twelve panel or eighteen panel does not matter. In molding the two halves of the soccer ball should be aligned evenly and the flash line neatly trimmed. The circumference, weight and rebound should correspond to those figures given for leather-covered balls (see pages 237–238).

PLASTIC COATED. Although not available as yet on the market, a plastic-coated, or fabric-coated, soccer ball has been tested under controlled laboratory and field conditions. The cover is made of vinyl resin or thermosetting polyvinyl butyrol. The rest of the ball is similar to a sewn, laced leather-covered ball.

Shin Guards

Soccer shin guards are of three types: plastic, reed and cloth. The best type is made of molded plastic in one piece. This type will distribute the blow to the whole leg, whereas the reed type of shin guard will not. Webbed cross straps across the inside of the shin guard prevent any contact with the leg, and help to distribute the blow. Reed shin guards afford some protection but those of cloth do not offer more than the barest of protection Some type of shin guard should be worn any time that cleated leather shoes are worn. It is best to hold the shin guards in place by fitting and securing inside the stocking.

Uniform

Warmth is a primary consideration in soccer clothing, since this sport is usually played during the cool brisk fall or cold winter months. Provision must be made for a wide range of leg movement. Protection for the feet is an essential safety factor. With the exception of the items listed here, costume for soccer is the same as that worn for gymnasium activities (consult Gymnasium Costume, pages 288–296).

According to the official rules, the usual equipment of a player consists of a jersey or shirt, short trousers, stockings and boots. A goalkeeper should wear colors which distinguish him from the other players.[2]

SHORTS. Soccer pants are longer than the usual gymnasium shorts (3 to 4 inches above the knee) in order to provide warmth. Width of leg opening and full cut in the hips permit ease of leg action. Pants are cut straight across on the bottom of the pant leg and not on the diagonal (slant) as is done in gymnasium shorts. A pocket may be placed on the front or on the hip in back of the pants. Pants may be purchased in plain, twill or satin weaves. Although cotton or cotton and wool combinations are used in soccer pants, wool is the most desirable material because of its warmth-giving property. Most soccer pants are made up in solid colors. Pants do not usually have extra trimming or contrasting color inserts.

SHIRTS. Long sleeves and a snug-fitting collar (Byron) provide warmth. Collarless jerseys have a high cut, round neckline. Close-knit jersey construction, and worsted or heavyweight cotton meet the need for warmth of the upper part of the body. Shirts come in solid colors, stripes (usually diagonal), and solid colors with contrasting color at neckline and sleeve cuffs.

HOSE. With warmth again a primary consideration, socks are knee length and of a fairly heavy woolen knit construction. Shin guards are placed under the socks, so that a flexible knit construction is essential to a good fit. Most players double the sock at the top by folding it over or under for extra protection on the front of the leg. Since some players are allergic to wool or dislike a rough wool texture next to the skin, some socks are lined with white cotton. Separate cotton knee-length hose may be used under the wool socks in place of the wool cotton-lined variety. Solid colors with contrasting colored stripes are widely used.

SHOES. Shoes are the most important part of a player's equipment. The shoe uppers should be soft and pliable, yet firm enough to provide ankle protection, and should be cut low in the back to allow proper extension of the ankle. Horsehide is often preferred to cowhide because of its close grain. A low box toe is much preferred to a high box toe. Shoes with straps atached to the sides which pull tightly across the instep help support the arch and provide some support for the ankle. For a shoe which has no straps a tightly-

[2] *Ibid.*, p. 73.

wrapped lace under the arch and over the instep is a satisfactory substitute.

All soccer shoes for men must conform to the following standards:

> All bars and studs must be made of leather or rubber; nails shall be driven in flush with the leather or rubber; bars shall be transverse and flat, not less than half an inch in width, and they shall extend for the total width of the boot and be rounded at the corners; studs shall be round in plan, not less than one-half inch in diameter at the exposed surface; combined studs and bars may be worn provided the whole conforms to the general requirements of this Law; bars and studs on the soles or heels shall not project more than half an inch and shall have all fastenings driven in flush with the leather or rubber. Metal plates, even though covered with leather or rubber, shall not be worn.[3]

Official rules for women specify that

> High cloth shoes with a rubber or leather disk over the inner side of ankle and extra tips for protection over the toes, may be worn. Leather shoes protect the feet best and may be used, but metal plates or projecting heavy sole are not allowed.[4]

Shoes with removable cleats (or studs) are easier to keep in repair than are shoes with nailed-on cleats. The latter type tear the sole of the shoe when they pull off. Bakelite or rubber cleats are less dangerous than those that are nailed on, since nails often protrude when the cleats are worn down. Leather cleats become detached from the shoes easily and may cause injuries to the feet and ankles because of the resulting unequal surface created.

Many coaches and players prefer cloth shoelaces to leather or rawhide, since cloth will not shrink or stretch as much with changes of atmospheric conditions. Lightweight shoes are conducive to more speed, but sometimes offer less protection.

For physical education classes, intramural and interscholastic competition, cleated shoes should be worn by *all or none* of the players. Regular rubber soled shoes with canvas and leather uppers, tightly laced, are satisfactory for class activity, but low cut shoes should not be allowed.

Care and Repair

For information on care and repair of types of soccer balls see pages 268–269.

For shoes, see pages 264–267.

[3] *Ibid.*, pp. 73–74.

[4] *Official Soccer-Speedball Guide,* 1950–52, p. 46.

VOLLEY BALL

Volley ball as an organized sport dates back to 1895 when W. J. Morgan began instruction in what then was an experimental activity. The game was based on tennis, but the net was raised, and an inflated rubber bladder hit over the net with the hands replaced the tennis ball and racket. A basketball and then a lighter, smaller ball (volley ball) was substituted. After the introduction of volley ball at the YMCA in Holyoke, Massachusetts, the game spread over the other New England states and eventually became an international sport.

Equipment

Ball	Uniform
Net	

Ball

Just as with soccer balls, the trend in volley ball construction is toward a larger number of panels. The most expensive, but not necessarily the most durable balls have an eighteen panel construction; however, there does not seem to be any correlation between the number of panels and playing results. On the other hand, it has been found that the stitching has been the cause of a great many failures. The greater the number of panels, the more stitching needed in the construction.

Official rules of the United States Volley Ball Association stipulate that the ball must be made of a rubber bladder and covered with a twelve-piece laceless leather cover. It should measure not less than 26 nor more than 27 inches in circumference and should weigh not less than 9 nor more than 10 ounces. The air pressure should be 7½ to 8 pounds. For games played out-of-doors a heavier ball may be used, but it should not exceed 12 ounces.

At present, there are four types of construction used in the manufacture of volley balls.

LEATHER COVERED, STITCHED. Whether the ball has twelve or eighteen panels and whether it is laced or laceless is a matter of personal choice. The laceless ball seems to be the most popular. For selecting or inspecting leather-covered stitched volley balls, the following characteristics should be checked:[5]

1. Dimensions for circumference, weight and rebound—between

[5] United States Office of Quartermaster General, *Ball, Volley*, October 30, 1944, pp. 2–4.

25½ inches and 27 inches in circumference; between 9½ and 11½ ounces; and, when dropped from a height of 72 inches, rebound should be 45 to 55 inches.

2. Leather panels for leather—no holes, cuts, loose fibers, sponginess or broken grain. For balls clearly sold as blemished, slight stains, healed-over scars or other imperfections are acceptable so long as they do not affect the serviceability of the ball.

3. Seams and stitching—no needle cuts, loose stitches or broken

Figure 67. Volley ball—rubber covered. (*Courtesy of W. J. Voit Rubber Corporation.*)

stitches. If panels are incorrectly joined together, wrinkles along the seams will be in evidence. Inferior quality leather will also create wrinkles along seams.

4. Valve—should not be pulled away from the casing and should be trimmed flush with the surface of the ball.

5. Finish—should not peel, flake or crack when the leather is bent upon itself, grain side out.

6. Lining—not less than two plies of herringbone twill or some fabric of equal strength.

LEATHER COVERED, MOLDED. The same information applies to this

type of ball as is given for leather-covered, stitched balls, with the exception of that relating to seams and stitches.

RUBBER COVERED. This ball should consist of a rubber bladder or air-retaining lining, a three or more ply fabric (rayon or cotton) or cord-wound carcass, and a white rubber cover vulcanized integrally with the carcass. The finished rubber-covered ball should simulate the appearance of the official leather-covered volley ball, and should have simulated seams of the conventional pattern molded into the surface. In molding, the two halves of the ball should be aligned evenly, and the flash line should be neatly trimmed. The circumference should be 26 to 27 inches, weight 9 to 12 ounces, and when dropped from a height of 72 inches, the ball should rebound 43 to 55 inches (see Figure 67).

COATED FABRIC. The coated-fabric or plastic-covered ball is identical with the leather-covered sewn ball with the exception of the cover. Where the leather-covered ball is made of calfskin, kipsides or horsehide, the coated-fabric ball has a cover made of vinyl resin or thermosetting polyvinyl butyrol. It should be white in color and non-tacky.

Net

Volley ball nets are intermediate in size, between badminton and tennis nets. They must stand much harder wear and tear than a badminton net and equally as much as a tennis net, since in volley ball the ball may be played on the rebound from the net. The top tape must be durable to withstand the friction of the ball during volleying and especially on spikes. The cable (or suspension rope) must be strong enough to support the weight of the net in tension, and bottom tie ropes should be strong enough to maintain the bottom of the net in a taut position. Nets that are used outdoors should be treated for resistance to moisture and mildew.

Specific requirements concerning the size, material and construction of various parts of a volley ball net have been drawn up both by the sports groups that determine official volley ball rules for men and women and by the Quartermaster Corps of the United States Army. These regulations are listed as guides for all purchasers of volley ball nets.

The official rules for women state the following:

> The net shall be three feet wide overall and 32 feet in length when stretched. It shall be made of a four-inch square mesh of black or dark brown No. 30 thread. The net shall be bound top, ends and bottom with one-quarter inch manila rope. A double

thickness of white canvas, two inches wide, shall be sewed to the top and ends of the net, through which shall be run a wire cable one-quarter inch in diameter.[6]

The same size net is used in men's volley ball games.

More detailed specifications have been written by the Quartermaster Corps. Some of these requirements follow:

1. Body of net—approximately 4 inch square mesh reasonably fast to light; netting of twine or tape not wider than 3/8 inch.

2. Top support—not less than 2 inches wide in finished construction; binding of white tape, fabric or webbing doubled over the top of the net and securely sewn to the net with not less than two rows of stitching, 6 to 8 stitches per inch, 3/4 inch gauge and the first row not less than 1/8 inch from the edge; a brass grommet shall be set in the binding of the top support approximately 2 inches from each end and a top tie rope, 6 feet or more in length, doubled through each grommet.

3. Bottom tie rope—1/4 inch diameter jute rope or better.

4. Side binding—4 inches wide white canvas or webbing . . . and shall be doubled over the side of the net and securely sewn to the net with not less than one row of stitching, 6 to 8 stitches per inch, and not less than 1/8 inch from the edge; all ends of rope and twine shall be served or clamped with a metal rope clamp to prevent unlaying.[7]

The following factors influence the cost of volley ball nets:

1. Quality of twine—#30 best, #24 medium, #12 minimum.

2. Quality and size of binding—good quality heavy duck or canvas 2 inches doubled is used on best quality nets.

3. Amount of taping—the most expensive nets are taped top, bottom and sides.

4. Type of net cable—the best nets have steel or manila rope.

5. Size—some cheaper nets are smaller than regulation size (32 feet by 3 feet).

Uniform

See Gymnasium Costume, pages 288–296.

Care and Repair

For information on care of a volley ball, see pages 268–269, on the net, see page 206.

[6] *Recreational Games—Volley Ball Guide,* 1949–51, p. 108.

[7] United States Office of Quartermaster General, *Nets, Volley Ball,* December 9, 1944, pp. 2–3.

HANDBALL

Ever since the early days of handball historians of athletics have associated the game with Ireland. It has been a favorite sport in that country for centuries, but only within the past 100 years has it spread to other nations, including the United States. The rules and equipment have undergone many changes during the development of the game. Originally the ball was similar to the present baseball with a cork center covered with rubber yarn over which a horsehide cover was wrapped. It was the size of the present handball but very hard and fast. At that time the ball could be kicked. In handball as it is played today a rubber ball has replaced the horsehide-covered ball and is used in both types of games: four walls and single wall.

Equipment

Ball	Uniform
Gloves	

Ball

The official black rubber ball used in either the four walls or the single wall game is about 1⅞ inches in diameter and about 2⅓ ounces in weight. According to Quartermaster specifications:

> The ball should be manufactured from natural or synthetic black rubber and should be the inflated plugless variety, consisting of a two-piece vulcanized rubber shell. The diameter should be between 1.844 and 1.950 inches; the weight, 2.10 to 2.40 ounces and the rebound, when dropped 100 inches onto a solid horizontal surface should measure 57 to 65 inches.[8]

A ball that is lighter, larger and softer than the official handball is used quite often in many communities. It is about 2¼ inches in diameter and 2 ounces in weight. Some colleges and universities use the above ball for physical education classes and intramural contests; but for individuals deeply interested in the game of handball, such a practice is not recommended because of the greater speed, difference in bounce and general liveliness of the smaller, harder ball. Many of the schools and colleges using the larger ball make it still softer (when the contestants have no gloves) by puncturing it with a hypodermic needle, thus allowing some of the air to escape.

[8] United States Office of Quartermaster General, *Handballs,* November 28, 1947, p. 2.

Glove

Some type of glove is usually worn as protection for the hands when playing four-wall handball. Where the game is played against a single wall, such as at beaches and public parks, and when the large soft ball is used, gloves are not essential.

A regulation handball glove should be made of best grade cowhide or horsehide leather. It should be soft and pliable, free from cuts, holes and deep scratches. The glove should have a leather disk securely sewn to the inside of the glove and a ventilated back with adjustable wrist strap and buckle. The wrist edge and back opening edge should have a flat leather binding. Official rules prohibit the wearing of gloves with any type of webbing between the fingers. For informal play any used or discarded leather dress gloves will serve the purpose. Many handball players have started with just a pair of inexpensive work gloves.

Regardless of which type of glove is used, it should fit the hand snugly to ensure maximum control of the ball on all shots. For gloves which do not have an adjustable wrist band, a piece of adhesive tape applied lightly or a heavy rubber band will produce the same effect. Extra padding in the center of the glove gives added protection but decreases the amount of control on each shot.

Uniform

See Gymnasium Costume, pages 288–296.

CHAPTER XV

Track and Field

Running and jumping are generally conceded to be the most universal of all sports, perhaps the earliest form of athletic competition known to man. As sports they require somewhat less equipment than most other activities. Fleetness afoot was a matter of life and death to the ancient warriors, and races between athletes dressed in armor were features of the Olympic games as early as 6 B.C. Following soon after, running and standing broad jumps became regular events. The early running broad jumpers carried stone weights (called halteres) in order to gain added momentum and distance.

Early in the course of his life, primitive man learned that he could secure food and could strike his enemies at a distance by means of missiles thrown from his hand. Heavy sticks and stones became his earliest weapons and soon after were used in games. These events of throwing specially designed sticks and stones eventually appeared in the early Olympics. Later someone attached a handle to a heavy stone and the hammer throw came into athletics. Other new instruments were devised, and today the shot put, discus and javelin throw are standard track and field events.

Pole vaulting and hurdling are products of the Middle Ages. Professional runners were employed as messengers and heralds, and they frequently carried long, stout staffs which served a twofold purpose.

One end of the staff was used to carry emergency rations—a few ounces of wine, a bit of bread, and perhaps some cheese. Primarily, however, the staff was used to assist the runners in vaulting over fences and obstacles that were too high to hurdle. Cross-country routes usually provided the shortest distance between towns and villages. This professional runner of the Medieval Ages, was the predecessor of today's pole vaulter, hurdler and broad jumper.

The first spiked track shoes to be worn by an athlete in the United States date back to 1868, but records indicate that such shoes were used earlier than that in England.

Equipment

Vaulting pole
Shot
Discus
Javelin
35 pound weight
56 pound weight
Hammer

Uniform
- shoes
- shirt
- pants
- warm-up suit
- hose

Vaulting Pole

Bamboo, metal and fiberglass poles each have their advantages and disadvantages. Thus when selecting a vaulting pole a great deal depends upon the preference of the individual using the pole and the conditions under which it will be used. Bamboo poles will splinter and aluminum poles will dent if precautions are not taken for catching falling poles following each jump. Although some of the top-notch performers prefer bamboo, there can be little doubt that the metal poles are superior from the standpoint of safety.

Many manufacturers of vaulting poles specify that when ordering either type of pole the size and weight of the individual or individuals using the pole should be included with the order. To insure safe vaulting, poles should have the maximum weight stamped on a prominent part of the pole. Such maximums should be heeded. Some coaches suggest that 10 pounds be allowed as an additional safety factor, in other words, no athlete weighing more than 140 pounds should be allowed to use a pole stamped "maximum weight, 150 pounds."

BAMBOO. When selecting a bamboo vaulting pole consider uniformity of diameter, weight, color, length, straightness and whip, and weight of the vaulter. There is nothing about the length or

diameter of a pole that will indicate its potential strength. Each pole should be machine tested for and labeled with the amount of weight it will hold. Many coaches feel that a pole should have a minimum circumference of 5 inches at the butt; others prefer 6 inches. A pole with uniform diameter is essential to the vaulter for it allows a better hand grip and because of a more even balance, is easier to carry on the approach. With such a pole it is easier to shift the hands on the take-off.

Another aid in the selection of a vaulting pole is color, for color often indicates the conditions under which the bamboo stalk grew. A pole with a dark brown color may be old, dry and brittle. On the other hand, a combination of brown and green streaks may mean an uneven growth which causes such a pole to give an uneven amount of whip. A pole that is a very light brown color or one that has a greenish hue would indicate that the cellulose tissues are still spongy and full of sap. Such a pole will be too resilient.

Straightness is essential for good vaulting poles, but only rarely is an absolutely straight pole found. Therefore bamboo poles with slight curvatures are permissible. All bamboo vaulting poles after hard usage will develop longitudinal cracks (checks), but these do not seriously hamper the use of such a pole. However, a new pole with checks should be rejected. Taping will often lessen the number and size of the checks.

The desired length and weight of a vaulting pole are dependent upon many factors. The length may vary from 10 to 18 feet and is decided by the height of the jump. Twelve and 14 foot poles are most common in high schools, while most college vaulters will use a 14 or 16 foot pole. Coaches with limited budgets purchase a 14 foot pole for any height under 10 feet and a 16 foot pole for vaulting heights over 10 feet. A well-balanced 16 foot bamboo pole has a circumference of 5½ inches around the butt, 5¾ inches 5 feet up, 5¼ inches 10 feet up, and 4½ inches at the top. This size pole is suggested for the school or college vaulter who weighs approximately 150 pounds. A larger person requires a more sturdy pole, and a lighter athlete should use a pole in proportion to his weight. The weight of an average 14 foot bamboo pole should be close to 5 pounds 8 ounces, while a 16 foot pole should be around 6 pounds 3 ounces.

There are several methods of testing pole spring. One technique involves supporting both ends of the pole on benches or chairs and applying a sudden downward force at the center. In a second test the pole is placed as above, but the top end of the pole should be supported at the highest hand grip the vaulter will use in executing

jumps. Suspend a weight of 25 pounds midway between the point of highest hand grasp and the butt end of the pole. With a line stretched between the high points of the pole at the points of support, the pole should not bend more than 3 to 3¼ inches. Such a pole is said to have a moderate whip. A third method of testing resilience is by placing the butt end of the pole against a wall and then applying pressure at the free end. With the hands holding the free end of the pole and the pole held at shoulder height, body weight used as pressure should cause a moderate bend. It is best when possible to inspect the pole before the layer of tape has been wrapped between the joints.

METAL. Vaulting poles of aluminum alloy and of steel are available in lengths of 14 and 16 feet. Other lengths can be purchased on special order. Both the 14 and 16 foot poles are of uniform diameter, usually 1⅝ inches. However, a tapered 16 foot pole is available, in which the taper recedes from a circumference of 3¼ inches at the butt end to approximately 2½ inches at the top. The higher factory cost of producing the tapered metal pole raises the price to almost double that of the pole with a uniform diameter. Nearly all metal poles can be ordered to exact length and taper.

A pole that is constructed to meet exact specifications for diameter has a good uniformity of balance. Metal poles have a definite advantage over bamboo in this respect. Unlike bamboo, the construction process of metal poles can be controlled so as to produce nearly absolute straightness. Checks are never present because the pole lacks cellulose tissue.

The weight of metal poles ranges from 5 pounds 7 ounces (14 foot) to 6 pounds 2 ounces (16 foot). The aluminum pole offers very little weight advantage (1 to 4 ounces) over the bamboo for the athlete of average weight, but it is lighter than the bamboo pole required for heavy vaulters. Steel poles are 2 to 4 ounces heavier per length than aluminum poles. A layer of tape is necessary for good hand gripping on metal poles. It should extend from approximately 8 feet to 13 feet from the bottom of the pole.

Aluminum poles are less resilient than bamboo poles when both are submitted to the same weight conditions. As a result of bending when part of the weight is released at the execution of the pull up and the pushoff, a somewhat less effective whip is produced by the aluminum pole. The whip of a pole is to the advantage of some vaulters if it occurs at the right time. The degree of resiliency for steel poles is still debatable. The metal pole is far from rigid, however, and bends slightly under the weight of the vaulter. The amount

of bending and the subsequent whip are uniform regardless of the degree of rotation given the pole.

FIBERGLASS. Fiberglass vaulting poles were used in competition for the first time during the 1950 season. Very little is known about them. It is claimed that this type of vaulting pole equals other poles for resiliency and is much lighter in weight. A 14 foot pole is reported to weigh only 3 pounds as compared to the 5 to 6 pounds for poles of aluminum, steel and bamboo.

Shot

Aside from personal wearing apparel, the lone piece of equipment needed for shot putting is the shot itself. The men's rules prescribe that it should be a metal sphere weighing 16 pounds for college, Amateur Athletic Union and Olympic competition; 12 pounds for high schools and 8 pounds for elementary and junior high schools. For girls of college age the shot should weigh 8 pounds, and for high school girls, 6 pounds.

Shots are made of cast iron, bronze, lead, and a brass shell with a lead center. Lead, being a relatively soft metal, loses its spherical shape when used on any hard surface. Lead shots are often used for practice, but many conferences and leagues have ruled such shots illegal for official competition. The cast iron shot is the least expensive, the largest and most durable. The brass shell is smaller in circumference but most expensive. A bronze shot ranges in between these two in size and cost. Cost, size and wearing qualities should be considered when selecting a shot.

For indoor competition, the shot should be covered with a thickness of heavy leather. It is important that the leather lacing be sufficiently thick to withstand the heavy impact of each put. A strong rawhide lace is suggested for holding the leather cover to the metal shot.

Discus

The specifications for the manufacture of disci are detailed and technical. Briefly, the joint rules of the National Federation of High Schools and the National Collegiate Athletic Association prescribe that the men's discus must be made of wood and metal and weigh not less than 2 kilograms (4 pounds 6 2/5 ounces). The diameter must not be less than 219.07 millimeters (8⅝ inches). For high school competition, 3 pounds 9 ounces is the minimum weight, with a diameter of not less than 8¼ inches. *The Official Track and Field*

Handbook of the Amateur Athletic Union specifies that the discus for women's competition should weigh at least 2 pounds 3¼ ounces, and measure 7 5/64 inches in diameter.

Although not recognized for international or Olympic competition, colleges and high schools in the United States permit the use of disci made of rubber so long as they meet weight, size and shape specifications.

Those who favor the rubber discus claim that it is more durable than the all metal or the metal and wood discus. It is not only resistant to both chipping and denting, but also less affected by dampness. In addition to durability, those who advocate the rubber discus say that it is safer because it inflicts less severe injury upon anyone it might strike. A rubber discus is recommended for use on a clay surface or for indoor competition, since a rubber implement usually has a shorter bounce and skid than does the all metal or the metal and wood discus.

Javelin

The full specifications for size and construction of the javelin recognized for international and Olympic competition (for men) are given in *The Official Track and Field Handbook* of the Amateur Athletic Association. Briefly, it should measure not less than 8 feet, 6⅜ inches in length, weigh not less than 1.76 pounds, and be made of wood with a sharp iron or steel point. For women, the minimum length is 7 feet 2½ inches, and weight, one pound 5¼ ounces for college competition; for high school, 6 feet 8 inches and one pound in weight. Javelins are made of hickory, second growth ash or birch. When the javelin was first used in regular competition, a steel pointed head was attached to an ash shaft. In Finland Arno Hohenthal discovered that Finnish birch was much more suitable, also that the farther north the trees grow, the harder the wood becomes. He selected the sun side, outer layers of the birch trees and made them into javelin shafts. Athletes using both the ash and birch javelins discovered that the latter would sail from 30 to 35 feet farther. Sweden and Germany also make javelins with birch shafts.

The best javelin is one with a moderately rigid shaft, strong enough to maintain its shape at all times. The birch shaft meets this specification, but because of its rigidity, it is fragile and breaks easily when it hits the ground horizontally instead of being imbedded vertically or at an angle. For this reason, it is suggested that a novice javelin thrower use an implement other than one with a birch shaft. If the shaft is not straight or is too resilient, as occasionally happens with

ash or hickory, the javelin will develop a spin, causing greater resistance, thus decreasing the distance of the throw.

A javelin should be well balanced; the point of balance can be altered by adjusting the whipcord binding either forward or backward on the shaft. The rules stipulate that the space between the foremost point of the javelin and the center of gravity shall not be longer than 110 centimeters or shorter than 90 centimeters. This provision allows for a 7 8/10 inch adjustment of the whipcord binding in an effort to secure a better balance. Some athletes prefer a center of balance farthest from the metal tip, while others prefer it centered in the whipcord. Perhaps a majority want the center of gravity at a place in the whipcord as close to the metal tip as the rules permit.

In summary, it is advisable to check the following characteristics of a javelin in terms of the properties previously recommended: alignment, grain, resiliency, size of shaft, balance, length of metal tip, and specifications in accordance with official rules.

The use of all-metal javelins is still in the experimental stage, and because of limited manufacture, athletes and coaches have little from which to choose in the way of variety. It has been used considerably as a practice implement, and often by high schools in competition. Some metal shafts have little or no resiliency, a factor which many users say adds distance to their throws. At the present time wood javelins are in general use, but further experimentation may result in an all-metal javelin that will surpass and eventually supplant those made of birch, ash and hickory. Although the metal javelin is prohibited by international rules, its use is accepted under the joint rules of the National Federation of High Schools and the National Collegiate Athletic Association.

Weights

The 35 pound weight is no longer a regular field event in most college and university competition. However, it is a regulation Olympic event and is occasionally used in track and field meets sponsored by the Amateur Athletic Union. The greatest problem in selection is to be sure that the implement meets the required specifications.

The head of the weight should be round and may be made of either lead or a brass shell filled with lead. The spherical ball should have embedded in it a steel bolt by which the handle is attached. The handle is usually made of a small steel or iron rod, ½ inch in diameter, and bent to a triangular shape. The maximum length of any one side is 7¼ inches. Connecting the handle and the ball is an S shaped welded link, ⅜ inches in diameter. The implement should

weigh not less than 35 pounds and should measure not more than 16 inches in length. The specifications for the 56 pound weight are the same as for the 35 pound weight except that the S link is one inch shorter to compensate for the larger ball. This implement may not be more than 16 inches in total length.

Hammer

As in the case of the 35 and 56 pound weights, the hammer is used in few collegiate track and field meets. The spherical head of the hammer should be lead or a brass shell filled with lead. The handle should be made of spring steel wire (not less than 1/8 inch in diameter) or piano wire and may be looped at either or both ends to insure a better attachment. The grip may be either a single or double loop construction and it must be rigid with no type of hinge action. The handle should be connected to the ball by either a plain or ball-bearing swivel. Many coaches prefer the swivel type. A swivel may not be used to attach the grip to the handle. The complete hammer may not weigh less than 16 pounds and its overall length shall not exceed 4 feet.

Uniform

Clothing properties specifically needed in track and field suits vary with the nature of the particular event for which they are worn. High jump and hurdling events require design and fabric construction in pants that permit a wide range of leg flexion and extension. Fabrics for both running and jumping (especially high jump and pole vaulting) should be smooth, permitting the least amount of friction that would cut down time or hamper effort. High jump and pole vault costumes need styling that is close fitting without restraining action, so that the suit will not dislodge the bar. Freedom of arm action, important in all track costumes, is particularly necessary for all events involving throwing.

SHIRTS, SHORTS, HOSE. Regular gymnasium costume is worn for track and field activities with two exceptions: (1) many track shorts (pants) are designed with a V cut-out on the side to permit greater freedom of leg action (where this is not provided, an extra charge may be made for this feature); (2) shirts frequently have a sash design woven or sewn diagonally across the shirt from shoulder to waist, and may be of satin or sateen construction (usually of mercerized cotton).

The official National Federation Rules for boys' track and field meets state, "No competitor shall be allowed to compete without

his proper number, or without clean track shirt and pants." According to the official rules for women (National Section on Women's Athletics):

> Each participant must be suitably dressed for her event.
>
> Shirts should have sleeves of some kind, preferably regular gymnasium costume.
>
> Wide-legged or pleated shorts should not be worn. The regular gymnasium costume is preferable.
>
> Warm-up suits, sweaters, etc., should be used for warm-up periods, between events and after performance.

Instead of hose, some men athletes prefer to wear chamois skin pushers which prevent chafing, act as pads in loose-fitting shoes, and are easily cleaned.

SHOES. Track shoes, like any athletic shoes, need to be selected carefully and then given the proper care. They are of four qualities: those made of horsehide, cowhide, blue-back kangaroo and yellow-back kangaroo leathers. Shoes made of horsehide are fairly durable, heavier than shoes made of cowhide or kangaroo and the least expensive. Because of the stiffness of the leather it is impractical to use horsehide for the one-piece turned shoe construction (see page 136). Most horsehide shoes are made with the Littleway stitch construction and have tacked oak soles with permanent spikes. Cowhide or calfskin leathers are used in the slightly more expensive shoe and of the two, calfskin is a little more durable since it will withstand scuffing and hard wear, yet retain much of its appearance. Most track shoes made of trade-name leathers such as athletic tanned or Sportan are cowhide shoes. Kangaroo leathers are the best for track shoes because of their tensile strength and their lightness. Weight for weight, kangaroo is seventeen times stronger than any other known leather. Yellow-back kangaroo, because of the initial process of selecting and because of extra tannage, is considered to be the best. When appearance is the primary basis of selection few will deny that statement. However, some people in the athletic equipment field feel that for durability alone, blue-back kangaroo, in spite of the shorter tanning period, is just about as long lasting.

For all track shoes where economy is a major factor, it is recommended that detachable spikes be used. This allows several choices as to size and length of spikes when the track conditions are variable, whether it be indoor or outdoor. For general outdoor wear, the ¾

inch spike is recommended; for cross-country, 5/8 inch; indoor, 1/4 inch. Figure 68 illustrates one type of track shoe.

When selecting track and field shoes, it is vitally important that the shoe be not too large. It is recommended that *both* shoes be tried on at the time of selection and that the athlete fit them to the bare feet.

Figure 68. Track shoes. (*Courtesy of A. G. Spalding and Bros., Inc.*)

After regular and hard usage, a slight stretching is quite common and then light cotton socks may be used to further maintain the snug fit.

Jumping. Jumping shoes include any one of three general styles. Many broad jumpers use a regular turned construction, one-piece sprinting shoe with or without a padded heel. This style is the lightest shoe available, and by using some kind of rubber heel pad the jarring shock of take off and landing is reduced. Sponge or foam rubber is usually considered better than tubing or solid rubber, since it may easily be cut to size and, if desired, permanently fastened to the insole of the shoe by gluing or stitching. Felt pads, because of their almost negative amount of resilience, are not recommended. When heel pads are used the shoe counter should be of sufficient

height to provide a snug but not binding fit for the foot. A second style shoe is patterned after the sprint shoe, but has an extra high soft counter to provide additional snugness, thus decreasing the possibility of losing a shoe on the approach or during the soaring after take off. Still other jumpers prefer a more rigid shoe, one with a stiff high counter and one or two spikes on the heel. Athletes who have feet that bruise easily should seek the extra protection of this more solid shoe. However, the extra protection adds additional weight. The heel spikes provide extra traction at the take off.

High jumpers usually use shoes similar to those of the broad jumper, that is, a regular spring shoe with inserted heel pads. The extra lightness is the biggest advantage of this type, but its durability (due to its lightweight construction) is less than that of the heavier stiff-countered shoe. This latter shoe usually has six spikes on the sole and may have either one or two on the heel.

The athlete competing in the pole vault should select a high-top vaulting shoe since it affords extra ankle support not given by the low-cut sprint shoe. When light weight is a factor, regular sprint shoes are suggested. For an in-between—moderate weight and moderate support—a shoe similar to the seven- or eight-spiked high jumping shoe is recommended. The extra spikes provide more traction and take-off power and also may prevent slipping and sliding on a hard or slippery approach lane.

Running. The information concerning basic materials and types of construction previously mentioned is applicable to sprinting shoes. Yellow kangaroo for all-around performance and appearance is probably the best. Blue-back kangaroo is better than any other leather. The turned shoe type of construction is probably the best. The instep should be reinforced. The Goodyear lock-stitching process is excellent for track shoes where durability and moderate price range are important. A running shoe should have six spikes on the front of the shoe sole. Some coaches prefer an oxford type canvas top shoe with crepe soles and heels for cross-country, long distance events and indoor competition.

Field. For the discus, javelin, shot and other field events the shoes should be more durable than either the running or jumping type of shoes. The hand-turned shoe construction provides a light shoe but not one that has been stitched well. Since lightness is not the all-important factor, cowhide or calfskin leather is suitable. As for spikes, many players prefer six on the sole and none on the heel. Others

prefer one or two spikes on the heel. Just one spike is preferable for the shoe of the discus thrower.

Care and Repair

Track and field equipment other than shoes requires very little care. Seldom do the various implements wear out through hard or constant use. Most of the replacements are needed because of accidental breakage or loss during practice or competition.

Shoes

The leather uppers of track shoes should receive the same treatment as football and other types of leather athletic footwear. In addition, remove the detachable spikes, oil them frequently and replace them when worn down Send track shoes without detachable spikes to an athletic reconditioning plant when spikes need replacing. Too often this type of shoe is worn too long and then found to be beyond repair. Put on a new sole and spikes before the sole is worn through the welt. The greatest amount of wear often occurs in the area near the outside rear spike.

Rebuilt shoes are very satisfactory since the original construction produces a very pliable shoe, and when reconditioned the shoe remains very flexible and easy to fit. When nondetachable spikes are replaced on worn shoes one pair of uppers will outlast several pairs of spikes. Oil uppers frequently to keep down leather roughness and maintain their softness and pliability.

Athletes should always wear some other type of footwear when going from the locker room to the track and back. Walking on stones or cement dulls the spikes in a very short time. Also it will tend to push the spikes through the sole and insole, causing discomfort to the wearer. Never wear a pair of new shoes for the first time in a meet. New shoes will always stretch some, causing runners or jumpers to throw a shoe. Tape wrapped around the instep will provide added security but also adds more weight.

Track Equipment

Replace worn or torn tape on the *vaulting pole.* Do not add more tape than is needed for a satisfactory grip since tape adds weight. Check often to see if the plug is secure in the bottom end of the bamboo pole. Store vaulting poles in a rack in a horizontal position. Catch falling poles after the jump to avoid splintering (bamboo) or denting (aluminum).

Clean the *shot and weight* with kerosene and emery cloth. Oil and store in a dry place. Do not use lead implements on a hard surface or they will lose their spherical shape. Clean and polish the metal rim of the *discus,* varnish the wood portion to prevent water absorption.

Check the binding and steel points of the *javelin* for looseness. A loose wrapping will interfere with throwing and a loose point may cause the javelin to snap. Store javelins in a dry place and hang them from a nail or hook.

CHAPTER XVI

General Care and Repair

In order to provide maximum service and wearability of athletic equipment, an efficient program of care and repair is essential. Nearly all schools and colleges provide some type of care for their equipment; fewer schools do repair work.[1] Every school can conduct an athletic equipment repair program, however, but the degree of its completeness depends upon the availability of financial support. Some schools have only enough repair equipment to sew the slightest breaks in stitched leather goods; others have several sewing machines for repairing heavy leather and fiber goods. For the schools unable to do more than very minor repairs commercial companies who specialize in repairing athletic equipment are available. When sending equipment to a reconditioning company a school must pay a fair price for good service.

In schools that have their own repair departments, the cost of equipment repair varies with the location of the school. For schools in the Western Conference the cost ranges from 6 to 16 per cent of the total equipment investment, with the average almost 10 per cent. Cheap equipment which seems to be a saving is often more expensive over a period of years, because if the foundation is weak proper repairs cannot be made.

[1] Much of the information on care was taken from the following source: The Naval Institute, *Intramural Programs,* 1950.

Supplies

Following are recommended supplies for schools who wish to do their own repair work. This list, by no means complete, is sufficient to fulfill the basic needs of any athletic repair department.

1	Awl, Collar
3	Awl, Stabbing, 2½ inches
2 spools	Cord, Whipping
1	Knife, Leather Cutting
20	Laces, Cotton, White, for Boxing Gloves
10	Laces, Leather, White
40	Laces, Leather, Tan
1 quart	Linseed Oil
1	Needle, Collar, 3½ inches, Halfmoon
2	Needle, Glovers, #2, 19 Gauge
1	Needle, Collar, 5 inches, Halfmoon
2	Needle, Harness, Egg Eye, #2
6	Needle, Lacing, S Shape, 5½ inches
2	Needle, Harness, Egg Eye, #4
1 gallon	Oil (vegetable base)
1 quart	Paint
¼ pound	Paraffin
1 pair	Pliers, Lacing, Round Nose, 6″
1 set	Punch, Revolving, 6 Tube
1 tube	Quick-drying cellulose cement
1	Rubber-patching Outfit consisting of:
	1 tube Cement Rubber
	3 Patches, Oval 1″ x 2″
	6 Patches, Round 2″
	3 Patches, Square, 2″ x 2″
	1 Rubber, Patching, 3″ x 6″
	Sandpaper (sizes 00, 0, ½, 1, 1½)
1 pint	Shellac
2 pounds	Soap, Saddle (2 one pound cans)
6 pads	Steel wool
1 roll	Tape, Adhesive, 10 yards
4 rolls	Tape, Friction, ¾″ wide
2 cones	Thread, Cotton, Unbleached, 1/5, 1 pound per cone
2 cones	Thread, Cotton, Unbleached, 16/4, 1 pound per cone
2 cones	Thread, Linen, Unbleached, 8 Cord, 1 pound per cone
1 pint	Varnish
1 cake	Wax, Brown, Stitching, ¾ ounce

Following is a brief description of certain of the above items:

1. Awl, stabbing, 2½ inches long—of best quality carbon tool steel having a carbon content of 0.50 to 0.65 per cent. The awl should be round, tapering for 2/3 its length to a sharp point. The opposite end should taper to a flat end capable of fitting into an awl haft. A stabbing awl is used for general leather repairs where sewing or stitching is necessary.

2. Cord, whipping—black, of suitable construction and strength for whipping golf club shafts.

3. Laces, cotton, white, for boxing gloves—flat, braided, white cotton tape having minimum breaking strength of 45 pounds. Laces should be not less than 48 inches in length by ¼ inch in width. The ends should be folded lengthwise and stitched approximately 1 inch to prevent raveling.

4. Laces, leather—30 inches minimum, width approximately 3/16 inch, and thickness not less than 2/64 inch nor more than 3/64 inch, both dimensions being substantially uniform. The grain should not crack when lace is bent back upon itself grain side out. Breaking strength of the lace not less than 35 pounds.

5. Needles, collar, halfmoon—of a good commercial grade, made of finely polished and tempered steel.

6. Needle, glovers, #2, 19 gauge—of a good commercial grade, made of finely-polished and tempered steel, approximately 1⅞ inch in length.

7. Needles, harness, egg eye—of a good commercial grade, made of finely polished and tempered steel.

8. Needles, lacing—conventional S shaped, 5½ inches in length, 11 gauge wire with eye in the flattened end, and free of burrs or sharp edges.

9. Rubber-repair kit—rubber cement may be of a type ordinarily used for the repairing of automobile inner tubes which is also suitable for securing bladders to ball casings at the valve opening. The patches should be of natural rubber of a type ordinarily used in repairing of automobile inner tubes, capable of stretching with items to which they are cemented, and should not rupture or break under conditions of normal play. One side of each patch should be faced with a heavily sized, protective cotton material which may readily be peeled off when patch is to be used. Oval, round and square patches should have beveled edges. A buffer cap similar to that of tire repair kits should be used to roughen the surface to be patched.

Leather Shoes

Leather athletic shoes need considerable care if they are to give the utmost in wear, durability, comfort and appearance. Ripped seams in the uppers can frequently be stitched with the aid of a repair kit. Use waxed linen thread for sewing, the linen being stronger and more durable than cotton. The wax causes the thread to be quite water resistant and the stitch holes more impervious to water. Replace lost eyelets and smooth down rough edges of eyelets, lessening the number of torn and frayed laces. Knotted laces may cause discomfort to the wearer and will put undue strain on eyelets. Inasmuch as a new shoe quickly molds to the contour of an individual foot, many schools, after each season, send all varsity shoes to a qualified reconditioner to be relasted. This restores the original size and, to some extent, the original condition of the shoe. Discourage the wearing of shoes with cleats or spikes on stone or concrete floors. Good innersoles will aid in keeping an athlete's feet in condition.

Cleaning

In dry weather remove dust and line marking compounds at least twice a week. When shoes are damp, wet or muddy clean them daily. Use scrapers to remove the mud and dirt which might cling to the sole or between the cleats. Take special care to remove the mud which lodges between the shoe upper and the welting, for it is the stitches there that must withstand much of the wear and strain, causing the stitches to break. Use a small stiff brush capable of getting in between the welt and the upper.

Drying

Leather shoes are especially subject to damage if they are worn while soaking wet. Wet leather is soft and readily stretches out of shape. Stitches cut through wet leather more easily than through dry leather. If shoes are dried too fast and without proper attention, the leather shrinks, becomes hard, brittle and the shoes become misshapen. To dry shoes properly, wash off all the mud and grit with tepid water and oil or grease them. Straighten the counter, heel, vamp and upper to the proper shape. Crushed paper, forced into the shoe, will aid in absorbing moisture, and also help to maintain the correct shape. Push indentations in the box toes outward. Having taken these steps, place the shoes in a room of natural dry temperature, away from all dampness and moisture. Never use the intense

heat of a furnace or radiator to speed up the process. The use of an electric fan will help keep the air circulating. Shoes should be worn only after they are completely dry and have been oiled or greased.

Oiling and Greasing

The rational use of the proper kind of oil or grease will greatly increase the wear of shoe leather. Oil or grease shoes whenever the leather begins to harden or dry, or when it does not repel water. Before oiling or greasing, brush the shoes thoroughly to remove all the dirt and dust, then warm them carefully and apply warm oil or grease with a brush or swab of wool or flannel. The oil or grease should never be hotter than the hand can bear, and it should be rubbed well into the leather, preferably with the palm of the hand. Take special care to work the grease in well where the sole and upper are sewed together. After being greased, dry the shoes in a warm but not hot place.

Among the best materials for this purpose are vegetable, cod and castor oils, tallow, and wool grease or mixtures of them. The application of any oil or grease will darken light-colored or russet leather. Where this is objectionable—for example, in golf shoes—keep the shoes in good condition by frequent polishing. Castor oil is probably the most satisfactory oil for use on shoes that are to be polished. Appy the oil lightly to the clean, dry shoe and rub it into the leather until dry. If the application is light, the shoe may be polished immediately, but it is better to wait twelve to twenty-four hours. If the oil is applied too heavily, it will be difficult to polish the shoes satisfactorily, even after two or three trials. A shoe should not be soaked in oil, as this adds weight and is unnecessary unless waterproofing is desired. For soles a grease preparation is best, but be sure to remove cleats before applying the grease. A solution of 50 per cent orange shellac and 50 per cent linseed oil painted over the sole and cleats will help prevent mud and sod from clinging to the shoes on wet days. Do this from four to five hours before the shoes are to be used.

Waterproofing

For some sports in some climates it is desirable to grease shoes heavily to make them water resistant. Dry feet are important both for health and comfort and for best playing results. The ideal athletic shoe should permit the perspiration from the foot to pass out and at the same time prevent the entrance of water. Such a shoe, however, does not exist. Many manufacturers have been experimenting with a plastic sole and a plastic-covered welt shoe. If future service

indicates that such a shoe is waterproof undoubtedly more manufacturers of athletic footwear will adopt a similar procedure.

Waterproofing leather shoes has proven satisfactory for protecting the feet during rain or snowstorms. Such shoes will keep the perspiration in, but that is less objectionable than wearing heavy waterlogged shoes during any game played in the rain or while skiing. For warm weather the grease used for waterproofing shoes should be harder than that used during the winter. In warm weather the quantity of grease used should not exceed the amount that the leather will absorb without leaving its surface greasy. In winter, especially if the maximum water resistance is desired, a mixture of grease and oils which will not solidify is required. Use more grease than the leather will absorb. An excess will do no harm and will make the leather more water resistant. Extra grease, however, adds extra weight.

Many types of materials are available for waterproofing shoes, among them, these suggestions from a United States government bureau:

> For waterproofing shoes, nothing better than the following simple formulas is known to the Department of Agriculture . . .
>
> *Formula Number 1*
>
> Neutral wool grease—8 ounces
> Dark petrolatum (vaseline)—4 ounces
> Paraffin wax—4 ounces
>
> *Formula Number 2*
>
> Beeswax—2 ounces.
> Petrolatum—1 pound
>
> *Formula Number 3*
>
> Petrolatum—8 ounces
> Paraffin wax—4 ounces
> Wool grease—4 ounces
> Crude turpentine gum—2 ounces
>
> *Formula Number 4*
>
> Tallow—12 ounces
> Cod oil—4 ounces[2]

In each case melt the ingredients of the mixture together by warming them carefully and stirring thoroughly. Better penetration is obtained if the grease is applied warm, but it should never be hotter than the hand can bear.

Grease thoroughly the edge of the shoe and the welt. Thoroughly impregnate the sole with the grease, thereby increasing its water resistance, durability and pliability. The sole can be most conveniently waterproofed by letting the shoe stand for about fifteen minutes in a shallow pan containing enough of the melted waterproofing material to cover the entire sole. Never allow rubber cleats or rubber heels, however, to stand in the grease, as it softens the rubber.

[2] *The Care of Leather,* Farmers' Bulletin, No. 1183.

Cleats

Before issuing new or reconditioned shoes, check cleat assemblies and cleats thoroughly. Do not assume that these units are perfectly tight. In drying out, leather will contract, and the shrinkage from the base of the cleat to the sole may be such that the cleat may be safely given a complete turn. It is absolutely necessary that cleats be checked for uniform length and tightened frequently. Cleats seldom strip off when tight and cleat fixtures do not loosen easily when cleats are drawn up flush with the sole. Irregular cleat lengths will cause undue strain and make counters run over. Mud cleats, because of their extra length, need special attention. The longer the cleat, the greater the possibility of stripping off. When a mud cleat is lost it is easy to twist a knee or turn an ankle. Never tighten a cleat to such an extent that it bulges or flares out at the base. When the base spreads from excessive tightening it invariably means that the composition material has sprung away from the inside metal part and the cleat will come off.

When starting cleats on the bolt, take care not to cross the threads. Both nut and bolt thread may be stripped. Tighten first with fingers, then apply a wrench or pliers, turning cleat slowly to insure a snug fit with the sole. A drop of oil on the post will make the task easier and also aid in preventing rust and corrosion. Rust and corrosion may cause the entire assembly to turn in the sole when being removed. Rusted cleats may be removed by cutting, using a hacksaw or heavy wire nippers. A new post must then be inserted. Some posts are equipped with a single nutpost arrangement, and others employ a clinch washer over a fluted post device. Both types of posts are easily replaced. Cleats may turn both ways on the posts while the latter remain tight in the sole. This means the nut inside the post has worked loose from the cleat and should be cut away immediately before damage is done to the post assembly. Be careful to cut only the cleat, so that the post thread may not be damaged.

Canvas Shoes

Wash shoes frequently in lukewarm water with a little liquid soap and a dash of formaldehyde added as a deodorizer. This treatment is very effective in destroying foot odors. Shoes, when partly dry, may be put in the sun. Check laces frequently, as frayed and knotted laces will cause the eyelets to be pulled out of shoes. Replace lost eyelets and repair small rips or snags at once. Never stuff hose that are damp from perspiration into shoes. Open the shoe tops to insure thorough drying.

Leather Balls

Only a physical education instructor or an experienced equipment manager should look after and repair leather balls. These are expensive items of equipment and can be damaged if over-inflated or cleaned incorrectly.

Inflation

Over-inflation of any type of ball strains the fabric lining. Inflate ball to pressure specified on the ball, but never over-inflate. When inflating a ball with a rubber core valve, unless otherwise directed, moisten the inflating needle (standard size), preferably with glycerin. If the needle is moistened with the mouth, remove moisture from the needle before using it. Insert needle with rotary motion up to the shoulder of the needle. Never use a rusty needle as it will injure the valve core and cause air seepage. When the pressure of the ball has been checked with an accurate air gauge, the needle should be twisted out in one smooth and continuous turn. Never use a filling station pump to inflate any athletic ball as it can easily over-inflate or burst the ball.

Cleaning

Use saddle soap to clean balls. If, due to repeated wetting and drying, harshness develops, apply vegetable oil or light paraffin (mineral oil) to the leather surface. Apply this coating of oil in thin uniform coats, allowing several hours to elapse between coats. Inflate wet balls almost to normal playing pressure before drying. This helps prevent excessive shrinkage and hardening.

Storage

A mesh-wire cage or bin can be constructed for the storage of balls, and each type of ball should have a separate bin. This avoids crushing and allows plenty of circulation for drying. In addition, balls can be issued more quickly. Store balls partially inflated, sufficiently to hold their normal shape. Store in a cool, dry place.

Repairs

A rip occurring in the seam is easily repaired by unlacing the ball after it is deflated and working the carcass so that the portion which is to be resewed extends through the lace opening. Sew this with two needles and two threads, starting at a point approximately ½ inch

beyond the rip so that the new sewing will overlap and reinforce that portion of the original stitching. The use of a small awl is recommended as this will simplify the task of pushing the needle through until there are approximately six stitches of thread remaining on each side. Tie these two 6 inch ends together over the seam in a square knot. Using the awl to locate and slightly enlarge the hole, continue the process of sewing by placing first the right hand needle and then the left hand needle through the same hole and pulling the threads tight before proceeding to the next hole. Continue to sew in the above manner until the ripped portion of the opening is closed and you have sewed through three or four holes at the finishing end overlapping the original machine stitching. After the final stitch is pulled tight, tie the thread in a square knot and trim off the excess. Pound the seam, then, with a small hammer which will cause it to lie flat when the ball is reinflated.

In the event of a bladder failure in a ball, remove the bladder by working the fingers very gently around the portion where the bladder is cemented to the carcass so as to free the cement bond. After locating the hole in the bladder, it can be temporarily repaired by means of a standard tire tube cold patch, although a hot patch method is more satisfactory. To replace the bladder apply two coats of cement to the carcass at the valve hole opening in an area of approximately 2 to 2½ inches in diameter and two coats to the bladder in a similar area around the valve portion of the bladder after first having prepared the surfaces for cementing by buffing and cleaning with benzol or toluol. After the cement has dried sufficiently, exercise care in attaching the bladder to the carcass. Make certain that the projecting stem portion of the valve is inserted cleanly and completely into the valve hole in the leather ball.

Rubber-Covered Balls

Overall, rubber-covered balls are simpler to care for than leather balls, but can be ruined if particular care is not given to the inflation process. Follow instructions on page 268 carefully.

Cleaning

Wiping the ball with a damp rag usually removes most of the dirt accumulation; but if the ball has oil, grease or mud on it, use soap and warm water. The excess moisture on the ball will evaporate. Never use cleaning solvents on a rubber-covered ball; such solvents often tend to soften the material on which they are used.

Storage

Reduce the pressure in rubber-covered balls (to prevent constant strain), and store them in a *cool, dark* place, if they are not going to be used again soon. A chest, bin or closet is ideal for this purpose if it is not close to a sunny window or beneath a hot roof. Even when balls are out of play for only an hour or two, keep them indoors or out of direct sunlight. This precaution will assure the very maximum of service from any rubber-covered equipment.

Repairs

Any inflated rubber-covered ball which has been badly punctured should be returned to the manufacturer for repair. Do not attempt to patch large punctures because the ball may become lumpy, sticky, leaky and unbalanced. A patch on the surface will not seal a puncture hole in the bladder. A latex repair tube will often suffice for small punctures.

Mats

Canvass mats should be carried around the gymnasium, not dragged on floors. Clean them every week with a vacuum cleaner and repair small rips in the body or handles immediately. Depending upon use, clean mats about once every three months with commercial mat cleaner. If the mat is badly worn, send it back to the factory; they will recover it using the old filler. Painting of mats has proved very unsatisfactory because the paint comes off when the mats are given hard usage. Scrubbing the mats once a week calls for a regular paint job once a month. The mat becomes hard and slippery and loses its resiliency.

If necessary, rubber mats should be washed daily with soap and water. A zinc stearate or other antiseptic powder can be sprinkled over the mat to overcome some of the mat friction and to provide a sterilizing agent.

To repair rubber mats, roughen up the rubber surface of the mat about one inch from each side of the tear, being careful not to buff too deeply as the rubber coating is thin. Then cut a proper sized patch, round the four corners to minimize loosening from scuffing, and roughen up one surface of the patch with sandpaper. A coat of cement should be applied with a brush to both the mat surface and the rough side of the patch. Allow the cement to dry five or ten minutes, or until the solvent is all evaporated and the cement feels tacky, but not moist, then brush on a second and third coat, allowing

each to dry thoroughly. The cemented side of the patch should be rolled onto the prepared cemented place on the mat. A patch also should be cemented on the opposite side of the mat cover, using the same technique. Allow forty hours for the cement to cure fully at room temperature.

Plastic mats, like rubber, can be washed with soap and water, but unlike rubber, can be cleaned with commercial mat cleaners or regular types of cleaning fluids. Where more than one plastic mat cover is used to cover a large area, it is important that all the covers be laced together tightly.

CHAPTER XVII

Clothing as Equipment

Selection of clothing has through practice become a routine, simplified procedure for most individuals. In reality, the ability to purchase intelligently is based either consciously or subconsciously on a number of considerations, each of which determines the ultimate worth of the item selected. For example, choice of any apparel is governed by the properties of fiber and fabric essential to optimum functioning of the garment, attractiveness of the color, and quality of the garment construction. In addition, the cost of the garment and the kind and amount of care which it requires are taken into consideration, and in active sportswear thought is given to those features of styling that contribute to freedom and ease of action.

Guides to Selection

Certain characteristics of clothing must be kept in mind in order to purchase intelligently.

Function

Intelligent buying must be based on a knowledge of the function of the item that is to be selected. In sportswear the primary function

of the garment is to contribute to movement. There are many concomitant functions growing out of this basic purpose—such as appearance, comfort and wearing qualities—and their importance is not to be minimized; but function in terms of ease of movement must remain most important. Factors that affect the function of a garment include such variables as nature of the activity, local conditions, appearance, comfort, wearing qualities, suitability, safety, care, repair, cost, and guarantee and testing. Too frequently a failure to consider each factor or a tendency to place emphasis on one alone results in dissatisfaction. For example, a costume may be comfortable, but at the same time unsuited to the style requirements of the individual. Appearance is sacrificed and in that respect the costume fails to function fully. Again, appearance may be excellent, but wearing qualities are poor, and therefore the function of the garment is not served. A check-list to guide the consumer in intelligent purchasing has been devised and can be found in the Appendix.

Color

The emancipation of sports attire from the full, drab colors of a previous era has been at last successfully achieved. It reflects the emergence of physical activity from a rigid, formal program of exercises to the free, natural sports activities that are enjoyed today. A few suggestions for the use of color in sportswear follow:

Avoid warm colors for any vigorous sport played during warm weather, as a concession to the participant and to the spectators.

Avoid garments that are made up in primary colors of full intensity for those sports in which brilliant colors would be a distraction to the opponents or to the spectators. As a general rule, the use of bright, intense colors should be limited to trimmings, costumes worn against dull or monotone backgrounds (snow, colorless wintry landscapes), and sports played over a large area (golf course, beach, hockey field and other similar spaces). In all these instances colors will be more attractive to the wearer and easier on the eyes of spectators. For exhibition purposes also such colors add drama and life. At all times they should be worn only by those whose build can carry the colors with pleasing grace.

Avoid fabrics that have high sheen if the body build or proportions are large. Moreover, lustrous fabrics, with few exceptions, are not in keeping with the nature of sports activities.

Wear white apparel for tournament competition in racket type games. This is a sports tradition of long standing.

Garment Construction

Quality of fabric and color are essential to the optimum functioning of all clothing. These two standards by which to judge the excellence of any item of apparel are, however, incomplete without the addition of two other specifications, namely, good garment construction and style. Fortunately for the consumer all four requirements are closely interrelated in quality merchandise. It is the exception rather than the rule to find a substandard fabric in a well-constructed garment, and vice versa.

Previous to the perfection of mass production methods of manufacturing it was essential to have clothes custom made (made to individual specification and largely by hand) in order to secure apparel that was well constructed. Today that need is considerably minimized. Factories are turning out *en masse* well-made, well-tailored, and well-stitched garments. However, it is not possible to generalize on this fact to the extent of including *all* mass-produced clothing. It is still necessary to understand the fundamentals of well-made clothing in order to recognize these marks of quality when garments are selected. Characteristics of good garment construction are included in the Appendix, page 341.

Styling for Action

A well-cut garment is esential to the comfort and fit of all clothing. Some stylists contend that an excellent cut is sufficient for all purposes and label as orthopedic, details that are added to a garment for better fit and action. On the other hand, many argue that a garment stylish in fit for the ordinary activities for which it is worn cannot be expected to serve equally well when used for vigorous movement. The answer to this problem may be one that each individual wearer must discover for himself. To help him in this task a list of details in styling for action and fit is contained in the Appendix, page 338.

Cost

A popular misconception concerning clothing expense is the consideration of cost only in terms of the price paid for the garment. Actually, selling price is but one part of total cost and may in the long run represent an economy rather than an expense. Cost must be considered from two viewpoints: the initial outlay and the expense of upkeep. All consumers are familiar with the bargain that in a few weeks or months has served its usefulness. Time spent in

securing a replacement is an additional expense in terms of both time and energy—a hidden cost that must also be taken into account when the total cost is considered. The kind and frequency of cleaning that the garment requires, the need for re-application of temporary finishes, the effect of cleaning on fabric properties determine the cost of upkeep.

When purchasing any apparel keep in mind the following suggestions:

1. Remember the end use to which the garment is to be put. If durability and wearing qualities are primary, it may not be necessary to secure high-priced garments that have considerable hand work, extra details in trimming, or are classified as "one of a kind." Many articles marked as seconds have only minor defects which in no way detract from the general serviceability of the garment. Apparel of this type may represent an excellent buy. It is well to determine first the nature of the defect, and then weigh this factor against the purpose for which the garment will be used. The fact that clothing is imported may or may not add to its quality and cost. Some imported articles are less well constructed than their domestic counterparts. Others are as good or better than the domestic variety and less expensive because the cheapness of the foreign labor may have nullified the import duty.

2. Consider expense in upkeep in terms of time, energy and money. High-priced clothing usually represents all or most of the following qualities: top quality fabrics; handmade or hand-finished construction; unusual or unique weaves, patterns, colors, and design; top quality details (shoulder pads, trimmings, thread, belts); fullness of cut; fabric or garment finishes (preshrunk, crease resistant, colorfast to a variety of conditions and other similar finishing operations).

Care of Textile Fabrics

The kind and amount of care that any apparel requires is one of the major considerations when making a selection. Care involves expenditure not only of money, but also of time and energy. It affects comfort and improves or detracts from appearance. Due to the nature of the vigorous activity for which sportswear is worn, apparel of this type needs more frequent attention than most other clothing with the exception of work clothes. A brief summary of suggestions for care of textile fabrics and fibers is contained in Table 16.

Table

CARE OF

	General Considerations for All Fabrics	Cotton
Regular	Hang in cool dry place when not in use (woven fabrics). Apply deodorants (if used) some time before garment is worn. Use shields to protect shirts, jackets, dresses from deterioration and fading.	
Laundering	Launder or clean after every wearing (ideal). Check for sports and tears before laundering. Test small inconspicuous section for color fastness. Close slide fasteners. Use mild, pure soap flakes (preferable to soap), and soft water. Dissolve soap flakes first. Avoid rough handling and rubbing; squeeze suds through garment. Wash colored fabrics separately (in absence of colorfast guarantee); do not soak these garments. Rinse in clear warm water; do not wring or twist. Remove excess water. Hang in shade (unless garment is white) as sunlight is often harmful to color. Hang on smooth surface; hooks, knobs etc. may damage.	Wash in *hot* water if necessary. Use any good laundry soap; cotton resists strong alkalis well. Bleach white fabrics if increased whiteness is desired. Rinse thoroughly after bleaching.
Ironing	Check small inconspicuous section for correct ironing temperature if this is unknown. Dampen slightly (most fabrics). Use smooth, even pressure.	Use a *hot* iron if necessary.
Storage	Remove starch unless starch is guaranteed not to weaken. Be sure garments are clean and dry. Inspect for moths and other insects. Store in cool, dark place protected from dust and dirt. Spray storage area occasionally with effective mothproof agent.	
	Special Considerations for Knitted Fabrics	
	Repair runners at once. Measure before laundering (unless garments are shrinkproof). Dry on a flat surface (do not hang up). Do not use pins on these fabrics. Lay flat when storing.	

Covered Rubber Thread	Nylon	Rayon	Wool
			Brush frequently, especially cuffs, neckline etc. Air frequently; dust and dirt adhere easily.
Wash in *warm* water.	Do not use boiling water. Use any good laundry soap. Avoid strong bleaches. Remove some dirt and spot stains by simply rubbing with a damp cloth.	*Acetate* Use mildly warm water. This rayon melts easily. Choose soap carefully; alkalis dull. Use bleaches carefully if at all; bleaches cause saponification. *Regenerated* Wash very carefully; these rayons very weak when wet.	Measure before washing (unless shrinkproof). Wash as follows: Soak in warm sudsy water about ½ hour; change water and wash in warm soap solution. Rinse well; leave small amount soap in garment to prevent felting. Do not use chlorine or strong bleaches.
Use a warm not hot iron (rayon temperature for ironing is suitable). Do not use bleaches. Dry in natural heat, *not* in hot oven.	Iron with warm not hot iron. (Rayon ironing temperature is suitable).	Use warm not hot iron. Iron on wrong side. Iron when nearly dry except: rayon-wool-iron when dry; rayon-other fibers—iron when damp; rayon sharkskin—iron when noticeably damp.	Iron through a cloth placed on wrong side of garment. Treat with mothproof agent before storage unless garment is mothproof.
Store in relaxed position, not under tension.			*Note:* Avoid sharp changes in temperature in washing, rinsing and drying.

Special Considerations for Pile Fabrics

Do not iron some pile fabrics (unnecessary).
Expose reverse side of corduroy and velvets to steaming water. When dry brush pile side in direction of pile.

General Sportswear

Some items of apparel are worn for a particular activity only. In this group are included uniforms for basketball and football, field hockey tunics, ski suits and other specialized sports costumes. There are, however, some sports for which a variety of general sportswear garments are suitable. Clothing that is adaptable to a number of sports includes sport sweaters, dresses, shirts, pants and jackets. These garments are worn, with minor variations in styling, for golf, tennis, archery, bowling and similar activities for which general sportswear is appropriate.

Sweaters

If one garment were to be chosen above all others as representative of the most all-around item of sports apparel, the vote would be overwhelmingly in favor of sweaters (see Figure 69). The elasticity and comfortable fitting properties of this knit garment, plus the important quality of warmth, make it peculiarly adaptable to all climates and all types of sports. Add to this the element of comfortable yet unhampering weight and the picture of perfect sports clothing is complete. According to Webster a sweater is defined as

> originally, a heavy woolen garment, esp. a jacket worn to induce sweating; later, a sweat shirt; now esp., a knitted (or crocheted) jacket, jumper, or overblouse.

There are on the market now many garments that meet the specifications of the definition, but which are not considered sweaters. Strictly speaking, a sweater is constructed from animal fibers—wool, angora, and similar animal fibers. To this list is now added nylon, which for all practical purposes very closely approximates the animal fiber type of garment. As used in this book, the term sweater refers to either of these two basic fiber type garments that meet Webster's definition. Fine wools, such as cashmere, baby lamb, angora and camel's hair are unusually soft, lustrous and lightweight. The consumer must weigh these qualities against durability requirements. Wear and tear, especially at the neckline of pullovers and on the elbows of long sleeved sweaters, is a definite factor when durability is the main consideration. The contribution of blended fibers to this factor of durability, and the strength and abrasion resistance of nylon are other important considerations.

A great favorite for wear during the warm-up period before a game, sweaters are equally serviceable when the activity is over and gradual

Figure 69. Sport sweaters: (a) long sleeve, turtle neck pullover; (b) long sleeve, V neck pullover; (c) cardigan; (d) vest. (*a, b, d—Courtesy of Jantzen Knitting Mills, Inc.; c—Courtesy of Doris A. Weston, Fashion Counselors.*)

return of the body to normal temperature is an essential health factor. Because this type of garment is unhampering to bodily movement, it is frequently worn during active participation on cool days when a heavier jacket is unnecessary. Sweaters may be worn for practically every sports activity. Heavy, coarser quality wool sweaters, and sweat shirts have been a traditional part of school and college physical education programs; but a trend to more attractive styling, finer quality fibers, and less dull and harsh colors is indicated.

STYLE. There are two basic styles in sweaters—pullover and cardigan—with variations in sleeve length in each type. Choice of style depends on individual preference and on the end use for which the sweater is chosen.

Pullover. A pullover sweater may be worn alone or over a blouse or shirt (see Figure 69). If worn alone, a collar or scarf serves to soften the neckline. Lightweight pullovers are frequently worn under a jacket or cardigan. In the latter case the sweaters are usually referred to as a twin-sweater set. Pullovers are comfortable and do not require time for buttoning and unbuttoning. If the sweater is to be removed before play starts or during the activity, some women prefer a cardigan sweater because removal of the pullover style may disarrange the hair.

Necklines should be firmly constructed and with ample opening since additional strain is placed on this part of the garment as it is slipped over the head. A V neckline sweater or one that has a small collar with a short front neckline opening obviates this problem somewhat. The turtle neckline fits high and close to the throat and gives additional warmth in this area. Turtle neck sweaters can be worn without blouses, shirts or accessories.

The sleeveless vest type pullover is excellent for wear over a blouse or shirt when only a small amount of warmth is needed (see Figure 69) or for wear under a cardigan or jacket for additional warmth without bulk. In the reversible sleeveless sweater the color is different on each side and the garment can be worn with either side showing. This permits variety in color combinations and serves as two different sweaters.

Cardigan. Like the pullover, the cardigan sweater may be worn alone, or over another sweater (pullover or vest) or shirt (see Figure 69). In the latter case, because it is usually worn unbuttoned or buttoned only at the last few buttons at the bottom, it is particularly popular because such adjustment permits increase in warmth or coolness as the occasion warrants, or the sweater can be removed en-

tirely. The sleeveless type cardigan serves the same function as the sleeveless pullover. Cardigans have V or round necklines.

CONSTRUCTION. The method of garment construction varies in sweaters just as it does in other items of apparel. Top quality sweaters are distinguished by the following construction details:

1. Seams are small, smooth, and do not form a large ridge in the sweater; they are overcast with thread (or yarn) that is identical (or very closely matched) in color with the sweater proper. In some top quality sweaters seams are taped.

2. Armholes of plain knit sweaters are full-fashioned, an operation that requires the individual attention of the operator and hand manipulation of the machine on which the sweater is knit. Stitches are decreased so that a pattern is formed away from the seam, and the seam is consequently smoother and less noticeable. Sweaters that have a pronounced design (as in jacquard knitting) may not have this style sleeve construction since it would interfere with the pattern of the sweater.

3. Waistbands and sleevebands are added to the sweaters by means of knitting which gives the appearance of an uninterrupted knitting operation. Sweaters of lesser quality have seams at these points of the sweater.

4. Buttons and buttonholes are reinforced with material either on the inside or outside of the sweater. If placed on the outside this material, usually grosgrain ribbon, serves also as a decorative trim.

5. Neck openings of pullovers are large enough to prevent undue stretching when the sweater goes over the head. The ribbed knit at the neckline is attached smoothly to the neck opening and is firmly knit.

Necklines, waistbands and sleeve cuffs should be more firmly knit, preferably double ribbed, than the body of the garment for durability and good fit at these points. This is true of the armholes of sleeveless sweaters. Waistbands may be knit of covered rubber yarns for good fit and retention of shape.

As a rule, men prefer the boxy type of sweater, although some like and wear the semifitted style. Women vary in their preference of the three styles—fitted, semifitted and boxy. In sweater sets many women like a boxy cardigan worn over a semifitted pullover. The style selected depends mainly on personal preference or body build.

SIZE. Sweater sizes are based on chest measurement. If the sweater is to be worn at any time over a blouse or shirt or other sweater, it is wise to buy a size larger than the size for blouses or shirts.

Figure 70. Sports shirts, pedal pushers, slacks: (a) pedal pushers and polo shirt; (b) cuffless sport slacks (for women) with separate waistband, pleats and hip pockets; (c) long sleeve cotton shirt, turtle neck; (d) short sleeve cotton sport shirt (women). (*a and c—Courtesy of Garland Knitting Mills, Inc.; b—Courtesy of Algene Sportswear.; d—Courtesy of Susquehanna Waist Company and the Fashion Advertising Company, Inc.*)

Dresses and Skirts

Within recent years dresses designed to meet specific game requirements have been available in a wide variety of fabrics and in all price ranges. It is, therefore, no longer necessary for women to resort to the familiar sweater, shirt and skirt combinations as the only outfit that provides comfort and ease of movement, or to don their oldest, most loose-fitting tailored dresses. It is possible to purchase sports dresses that can double, with plenty of style, for good, basic dresses suitable for general wear. This advance in functional styling of sports dresses has been due largely to the rapid growth in the number of women who are participating in the sports for which dresses are worn. Golf, bowling and archery are claiming an increasing number of women participants. Tennis has long been popular, but the tennis style dress differs somewhat from those worn for the other three sports.

STYLE. Selection can be made in either one- or two-piece styles. Both types are attractive and have been designed for action and comfort. The one-piece dress is styled with full-length openings or separate waist and skirt openings. In the former style the front of the dress is buttoned or has a fly front with concealed full-length slide fastener. It is easy to get into or out of this style dress. In the two-piece dresses the waist and skirt are separate and the skirt, although usually of regulation length, is designed also in knee length for some sports, especially bowling and archery. Tennis dresses come several inches above the knee.

Skirts are styled for neat, trim fit at the waistline and sufficient fullness below for unhampered leg action. Some skirts achieve a softer look at the waistline by the use of unpressed pleats or small gathers, but the majority of dresses have an easy slim styling at this section.

SIZE. Although standard sizes of dresses based on body measurement have been adopted by manufacturers, there is still great variation in dress size. Dress sizes vary also for each of the following groups: women, misses, juniors and girls.

Shirts

Sport shirts, like sweaters, are worn for various sports activities and are basic to any complete sports wardrobe (see Figure 70). In cases where frequent changes of costume are necessary sport shirts are indispensable. They are cool, comparatively inexpensive, especially the knit cotton types, and lend variety to a wardrobe when combined with different skirts, slacks or shorts. From a utility point

of view shirts are excellent, since they launder well and may or may not require ironing, depending upon the material. Although usually worn over undergarments that absorb a considerable amount of perspiration, shirts must be effective in moisture absorption and at the same time retain an attractive appearance. If the shirt is to be worn without a jacket for activity out-of-doors in wet weather, purchase one that is water repellent.

STYLE. Like sweaters, sport shirts are manufactured in two basic styles: pullover and those with regular full-length front openings. Both types are attractive, durable and efficient. Shirts of the pullover style are called polo, basque and T. Sweat shirts and jerseys may also be classified as pullovers. Most pullovers are of knit construction with round collarless necklines (see Figure 70). Those with a small collar may or may not have a short neckline opening with two or three buttons, or a slide fastener.

Regular woven shirts with collar and full-length openings are similar to suit shirts and therefore can serve in a dual capacity. Partly for this reason many men prefer this style. It is popular also with men who like to wear the shirt over their slacks or shorts for coolness, comfort, or both. Women like this style since it can be put on or taken off without mussing the hair (see Figure 70). Another advantage of this shirt is that it can be worn over a lightweight T shirt which absorbs perspiration and enables the outer shirt to maintain its appearance for a longer period of time.

Both styles in sport shirts are made in knit and woven constructions. Knit shirts make possible a wide range of movement without the need for additional styling features for action. All else being equal, they absorb more moisture than woven shirts. The disadvantage in shirts of this type is that they fit closely and may feel clammy when wet. Strain on the garment at any point is minimum due to the give of any knit construction. Difficulty in retention of shape and less detail in styling are factors that militate against knit as contrasted with woven construction. Woven shirts must have styling provision for ease of movement since they lack the elasticity of the knitted variety.

SIZE. Sport shirts for girls and women are based on bust measurement, but those for boys and men are based on various standards of measurement. Woven shirts may be marked according to neckband sizes; knit sport shirts (such as T shirts, polo shirts and similar style shirts) are usually sold in sizes Small (28–30), Medium (32–34), Large (36–38).

Pants

Slacks and shorts are worn by both men and women for a variety of sports, including golf, tennis, archery, bicycle riding and bowling. In addition, women also wear pedal pushers (pants that are worn several inches below the knee) for bicycle riding, and culottes which are similar in length to pedal pushers but are very full and give the impression of a skirt until the individual moves quickly or vigorously. Men sometimes wear knickers for golf. These pants extend below the knee, fit firmly around the upper calf of the leg and are worn with knee-length hose.

STYLE. Loose, lounging types of pants or those that are poorly tailored have no place in active sportswear. Pants that are neat and well tailored are important not only to appearance but also to ease of movement. All pants, regardless of length, are subjected to considerably more stress and strain (with the exception of those worn for archery) than are pants worn for business or for passive types of recreation. There must be sufficient fullness across the hips and, in the case of pedal pushers and slacks, at the knee to permit bending and stretching with comfort. The crotch seam must be long enough to prevent binding, and reinforcement of the crotch is recommended. Tailoring must be trim but should not restrict movement. This is achieved by several means, including careful tapering and judicious placement of fullness and darts. Pants that have a continuous (as contrasted to a separate) waistband hug the waistline without binding and present a smooth, slim appearance. Pleats also add to a trim and tailored appearance.

Shorts. Shorts are now made in a variety of lengths including the short, medium and long short and a style that is popularly referred to as Bermuda shorts. Medium-length shorts are approximately mid-thigh in length; the short and long short are 2 to 3 inches above or below this length, respectively. The Bermuda short extends to the knee. Variations in styling of shorts include the straight cut short (see Figure 74), a neat, trim style especially suited to the slim, young player, and a fuller, more graceful short usually pleated (front or back). The greater width of the leg opening in this latter style short necessitates the wearing of an under-bloomer or pants that should match the shorts in color. This style short, as well as shorts of a medium or long length look particularly well on heavier players who are large through the hips or thighs. However, the long short tends to cut off height and gives a square, dumpy look to the short individual. Shorts may be cuffed or cuffless. Front and back pockets may be added

for detail as well as for convenience, since many players like a place in which to keep a handkerchief, especially if they wear shirts that do not have pockets.

Slacks. The styling of slacks is similar in some respects to that of shorts. The front of slacks may be plain or pleated, with pleats facing in or out. Waistbands may be continuous or separate with adjustable waistband devices or worn with a belt. Pleats are loose or stitched down. Pants legs are cuffed or cuffless. Some slacks have a patch pocket but all slacks have an inside hip pocket. The pocket opening is sometimes separate from the side opening in women's slacks. Pockets should be generously faced, especially the back pocket as the outside edge of the pocket lowers with wearing and the lining may show. Most men's slacks have slide fastener closings on the fly front. Slacks for women usually close with a similar fastener. Slacks used by men for tennis should not be too long or too full to hamper movement or cause the player to trip. For less vigorous sports, a normal, comfortable length slack is suitable. Figure 70 illustrates one style of slacks worn by women. Slide fasteners eliminate any bulge or bulk at closing. These fasteners may also be used on pockets instead of a flap. Crease-resistant finishes are good since slacks are likely to crease across the back of the knee as well as in other areas.

SIZE. Provision for adjustment in size is important, especially at the waistband, since on a hot day and during vigorous activity the player loses weight. Sizes of pants usually correspond to waist measurement and, in the case of slacks, to waist and inseam measurement. Some manufacturers are making slacks for women proportioned according to height. These slacks are available in size-height proportions as fellows: small (4 feet, 11 inches to 5 feet, 2 inches) and in sizes 10 to 18; medium (5 feet, 2½ inches to 5 feet, 6 inches) in sizes 12 to 20; and tall (5 feet, 6½ inches to 5 feet, 11 inches) in sizes 12 to 20.

Jackets

Jackets used for active sportswear may vary in construction and styling details, depending on the functional requirements unique to each sport. However, all jackets have two characteristics in common—they are designed to keep the player warm, and to fit comfortably and without restriction of movement over other items of apparel.

STYLE. With regard to the first desirable quality—provision for warmth—a jacket worn during vigorous activity out-of-doors usually is not itself a warmth giving garment. It protects the player from wind and rain, and maintains body heat provided by the garments over which it is worn. For this reason, jackets are usually manufac-

tured in lightweight, closely woven fabrics such as poplins and gabardines in cotton, rayon or nylon. Plastic jackets are light and waterproof and can be rolled into a small space when not in use, but are mainly useful in rainy weather, since their nonporosity makes them quite warm. In general they lack the body and appearance of a textile fabric. A hip-length jacket gives greater warmth in this area of the body than jackets that end at the waistline. The regular length for jackets is between waist and hip. Slide fastener closings and provision for a snug but comfortable fit at the waistline also contribute to warmth. Treatment for water repellency is essential for garments that are worn in rainy weather or snow. Double yokes at the back of the shoulders or water-repellent linings, especially across the shoulders, upper sleeves and yoke, also furnish additional protection from moisture. Slash-type pockets placed diagonally on either side of the jacket front at the height at which arms are comfortably flexed are ideal for warmth and comfort. They should be deep enough to cover the hands completely, and sufficiently roomy for comfort. Storm cuffs within the sleeve, rib-knit cuffs or any styling that permits adjustment of the cuff for closer fit contributes to warmth at this section of the jacket. A collar that is comfortable but fits snugly at the neckline is desirable, but should be the type that is also stylish when it is worn open in warmer weather.

Some jackets have slits (openings) for ventilation. These may be underarm or placed near the shoulder yoke. Many lightweight summer jackets are washable. A removable lining makes the jacket suitable for various types of weather and frequently facilitates the laundering or cleaning of the jacket. A reversible jacket is one that can be worn either inside or out. The two sides are usually different in color and pattern.

The requirements for each sport determine the type jacket that should be purchased. For example, a very short jacket is needed by fishermen who stand in deep water or surf; a lightweight, flexible jacket that can be rolled up and stored in a golf bag is useful for golf during rainy weather; a hunting jacket requires large roomy pockets in which ammunition can be stored. Jackets worn mainly for warm-up periods, such as blazers for tennis and athletic jackets worn by basketball, football and softball teams should be warmer than jackets worn throughout the entire period of participation in a sport. Wool or wool combinations, napped cotton or spun nylon are frequently used for these jackets. Some styling for action is important, and the jacket should be comfortable, but these factors are less urgent than in the case of the active sports jacket. Necklines of these jackets are frequently collarless.

SIZE. All jackets must be roomy enough to fit comfortably over other garments. For this reason, the jacket should be tried on over these garments when it is being purchased. A size larger than is worn in shirts or sweaters is advisable. In some cases, a jacket several sizes larger may be needed. Jackets are sized according to small, medium, large and extra large. These size groupings for men are usually as follows: small (36–38), Medium (40–42), Large (44–46), Extra Large (48 and above). Sizes of jackets for women usually conform to waist and bust measurements. Armholes should be low cut. The sleeve should be of sufficient length and fullness to permit arm flexion with ease and without appreciable shortening of the sleeve length. A smooth-surfaced lining enables the jacket to move easily against the garment underneath but it is not essential. Whether the jacket is straight cut or fitted, there should be provision for a comfortable, trim fit at the waistline. Jackets should be as lightweight as possible.

Gymnasium Costume

Choice of a gymnasium costume is a problem that periodically confronts most administrators and teachers of physical education. Selection may be limited to the merchandise of only one manufacturer. Provident administrators foresee this problem and plan in advance to have a range of sample suits for review. Regardless of careful planning, there still remains the problem of wise and intelligent selection. The necessity for more adequate knowledge of the properties essential to suits and the ability to recognize these properties wherever possible are strongly advised for all physical educators. The best use of available funds is contingent upon this basic information.

Early physical education programs in the United States consisted mainly of formal gymnastics and rigidly prescribed series of exercises. Students wore gymnasium uniforms, a logical if unimaginative title, since classes were conducted in the gymnasium and with great uniformity. Sports and activities representative of a modern, progressive philosophy of physical education bear little resemblance to this earlier program. Style in dress also reflects this change. There is functional quality in the streamlined versions now termed gymnasium suits. Compared to the voluminous, drab and constricting outfits of a previous generation, they are revolutionary. In a very literal sense their title is exactly appropriate—they are indeed "suited" to the vigorous movement for which they are worn.

The term gymnasium costume includes those items of apparel that are prescribed by a physical education department and worn

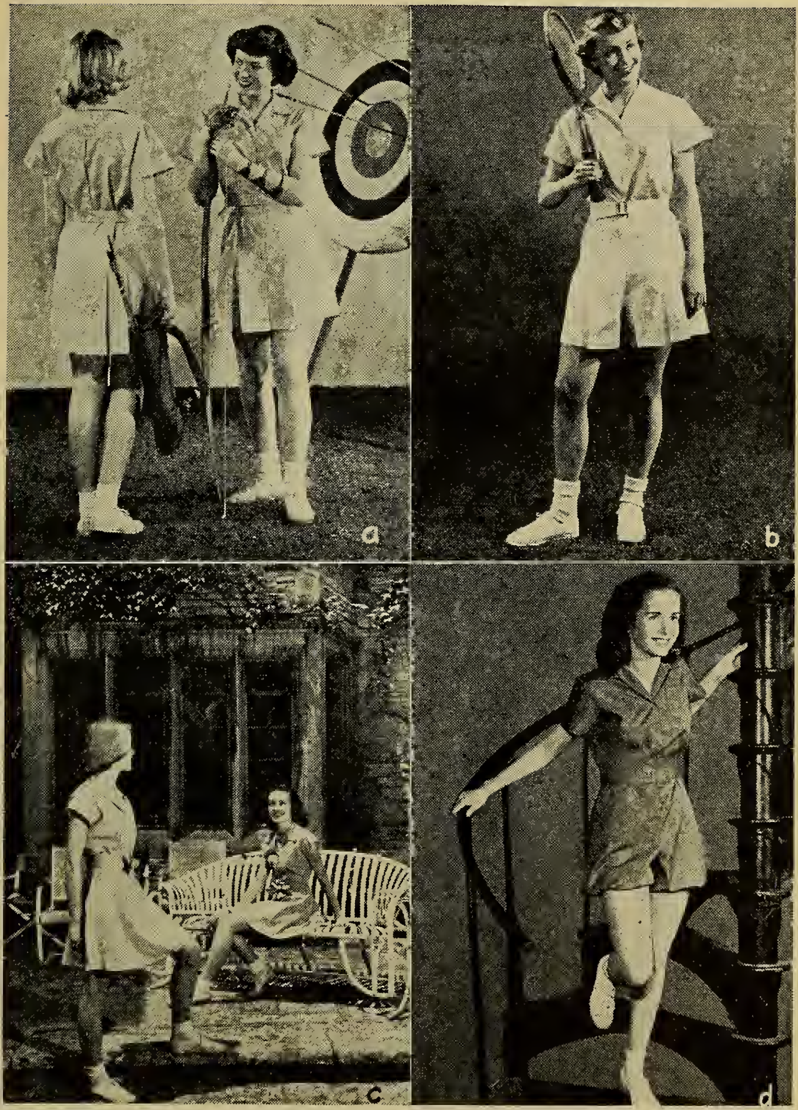

Figure 71. Gymnasium costume, one-piece suits: (a) shirt and tunic skirt; (b) shirt and shorts; (c) shirt and circular skirt; (d) shirt and rompers. (*Courtesy of E. R. Moore Company.*)

by students for their sport classes. Some schools require separate costumes for activities such as field hockey and tennis. These outfits are covered in other sections of the books. Swim (tank) suits which are usually prescribed and furnished by the school or college are also included under the heading of gymnasium costumes.

Gymnasium Suits

A standard suit, uniform for all participants, is required by most schools. In a number of institutions students are given a choice of color and participate in decisions concerning style. A few schools and colleges permit the wearing of any suit, individually owned, which is functionally styled and in good taste.

Suits are worn from one to five times a week and are subjected to considerable stress and strain incident to vigorous movement. In addition, they must be durable to withstand frequent laundering and ironing. In some schools and colleges the suits furnished by the institution are washed following each use. The importance of color fastness to washing is evident. It is inadvisable to store suits when they are soiled, but problems of administration and cost may make such a procedure unavoidable. In these cases the suits are usually kept in lockers or locker-baskets and are laundered less frequently than those supplied by the institution and laundered after each use. It is extremely important, therefore, that the fabric of the suit retain its shape well and be crease resistant. Resistance to perspiration and quick drying properties are also important. The same costume is worn for a variety of activities with widely differing ranges of movement. It is essential, therefore, that the garment be equally suitable in wearing qualities, comfort and appearance for every sport for which it is worn.

GIRLS AND WOMEN. The various styles of gymnasium suits can, for purposes of classification, be divided into two basic types: one-piece suits (see Figure 71) and two-piece suits (see Figure 72). The former classification refers to those suits in which the shirt and skirt or shorts are attached; under-bloomers may or may not be attached. Either a skirt or short styling is used in the lower half of the garment (see Figure 71). Pleats, cuffs, placement of pockets, types of belt and collar, the nature of the closing, and straight or flare cut, are all items which contribute to style variety. Two-piece suits refer to those gymnasium suits in which the shirt and shorts or skirt are separate items, unattached to each other. For general, all-purpose use especially for activity programs that include tumbling and stunts,

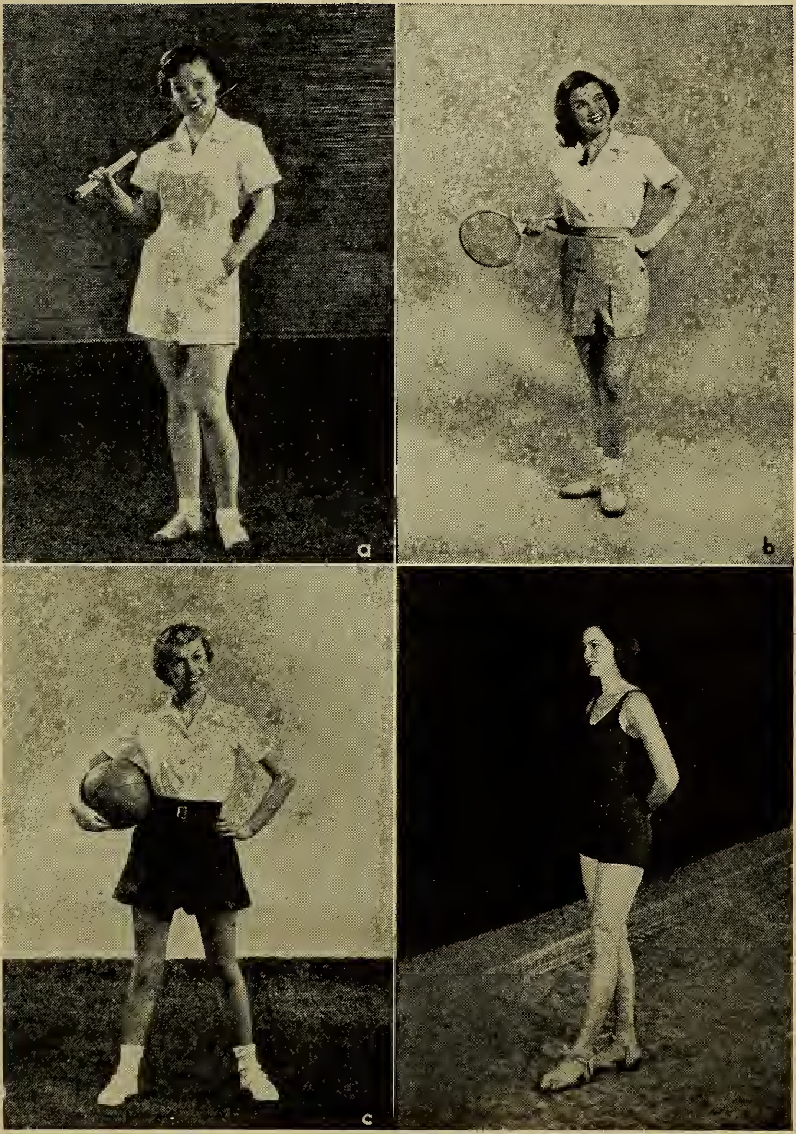

Figure 72. Gymnasium costume, two-piece suits and tank suit: (a) shirt and shorts (cuffless); (b) shirt and shorts (cuffed); (c) shirt and romper shorts; (d) tank suit. (*Courtesy of E. R. Moore Company.*)

rompers or straight cut shorts with narrow leg openings are more appropriate. Some suits are designed so that an inner bloomer is attached to the bottom of the outer shorts.

Busy school schedules allow less time for students to change into suits than is usual for most wearers of sports clothing. Therefore, suits must be styled for quick changes, and well constructed. Loss of separate belts and separate bloomers presents a greater problem in this respect than one-piece suits or those costumes in which such items are attached. Time is a special concern, also, in the matter of storing the suit after daily use. Suits that can be folded easily and quickly without the necessity of adjustment of pleats require less time and attention, and maintain a better appearance. This is particularly true if suits must be stored in small spaces such as baskets.

Color preference is sometimes guided by the colors of the particular school or college. In two-piece costumes, the shirt may be white or a lighter shade of the same color used in the shorts, giving a two-tone effect to the costume. In most institutions the same color is prescribed for all students. A few schools allow choice within a specified range of colors. Prints are not featured in gymnasium suits, although a few schools may permit students to wear play suits with a print pattern. If under-bloomers are worn they should be identical in color with the suit, or approximate it very closely.

Most concerns that supply gymnasium suits, furnish them in standard sizes. Shirt and one-piece suit styles are usually sized according to bust (or dress) measurements; waist measurements are used for sizes of shorts. Some concerns base their shirt sizes on proportional measurements of chest (bust), waist and hips. This presents a problem for the girl or woman who does not conform in body build to these set patterns. Unless the suit can be made to order, it is well to secure all necessary measurements of these students and order the size that fits the largest measurement, and then make necessary adjustments in size.

BOYS AND MEN. Gymnasium suits for boys and men are simpler in cut and style than those worn by girls and women. They also have less style variation. Standard suits for gymnasium activities such as informal games, relays, exercises, basketball, boxing, volley ball, handball and track are, with minor variations, the same. Basic costumes consist of shirts and shorts. With the exception of the variations that may be noted under each sport, the following styling is applicable to shirts and shorts worn for all sports.

Shorts are brief in length, with the leg opening cut on the diagonal to provide for freedom of leg action, and have button front closing

or elastic waistband. Button front shorts may have an elastic insert in the back of the waistband, a half-belt stitched onto the waistband, or a laced back. Some institutions that supply and launder the gymnasium costumes prefer shorts that utilize a drawstring attached to the back of the waistband. An opening of four inches closes when the string is tightened and tied. This type closing eliminates buttons, belts and buckles, and reduces laundering and ironing problems. The seat is cut full to allow for bending and the pants leg is wide enough to prevent binding. A 4 inch inseam is used. Athletic shorts purchased by the Quartermaster Corps of the United States Army are made of 9.2 ounce cotton, with a twill construction. An allowance of 3/8 inch is made for all seams, except double-lapped and double-stitched seams which have an allowance of 1/2 inch. All flies have four buttonholes; flies of shorts in size 38 and above have five buttonholes.[1] Trimming may be used for gymnasium suits. It is placed on the sides and/or waistband, and across the bottom of the leg openings.

The cost of shorts varies with the fabric type and quality. A heavier weight fabric is usually higher in cost. There is an extra charge for orders below a minimum number, as well as for the application of letters, monograms and trimming.

Both sleeveless and one-quarter length sleeve style shirts are worn. The former type have low-cut necklines and deep-cut armholes similar to men's knit underwear. Since both types are a knit construction, it is doubtful whether the sleeveless style provides any more freedom of arm and shoulder action than those with one-quarter sleeves that in addition absorb underarm perspiration and present a more attractive appearance. Custom, not function, seems to be the determining factor in retention of the sleeveless variety. Shirts that have one-quarter sleeves are similar to T shirts and have a round neckline with rib-knit band. Both shirts are collarless. Shoulder straps should be approximately 1 1/4 inches in width to avoid cutting and chafing. Shoulder and side seams should be securely seamed and cover-seamed. As in shorts, cotton is the most popular fiber. Rayon, which is a showier fiber, is used in some schools. Shirts are manufactured in solid colors and trimmed usually at the neckband or armholes and waistband. Price of shirts is governed mainly by the same factors that affect the cost of shorts, namely, type and quality of fabric, quantity ordered, and amount of trimming.

Gymnasium shirt sizes represent size of chest measurement. Sizes

[1] United States Office of the Quartermaster General, *Shorts, Athletic,* Amended October 26, 1945.

are as follows: Small (32–34); Medium (36–38); Large (40–42). Size listings for shorts represent waist measurement which has been cut in proportion to hip measurement of the average figure.

Supporters

Individual athletes usually select a supporter to suit personal likes and body build. Any supporter should be snug, comfortable, and should not bind or chafe. There are at least three types—all cotton, elastic cotton, and the web pouch—and two classes, woven and knitted. For most athletes and physical education students the woven elastic cotton supporter is suggested. The 3 inch waistband is adequate for most individuals, but some prefer a 6 inch waistband.

All supporters are listed in three sizes: small (26 inch to 32 inch waist), medium (32 inch to 38 inch waist), and large (38 to 44 inch waist). The measurements of a woven elastic supporter should approximate the figure in Table 17.

Table 17

SIZE CHART FOR ATHLETIC SUPPORTERS[2]

	Size 1—Small Inches (Approx.)	*Size 2—Medium Inches (Approx.)*	*Size 3—Large Inches (Approx.)*
Waistband	21	25	29
Width of Waistband	3 to 6	3 to 6	3 to 6
Length of Pouch	6½	7¼	8½
Length of Leg Straps	9½	10½	12
Distance between Leg Straps And Pouch	2	2½	3
Width of Leg Straps	1¼	1¼	1¼

It is recommended that protective cups made of light metal or plastic be worn when competing in boxing, catching behind the batter in baseball, or softball, and other similar activities.

Warm-up Suits (Sweat Suits)

As the name implies, warm-up suits are worn at those times when conservation of body heat is desired. These include periods before activity commences, rest periods during games, and all occasions when the weather requires warmer clothing. Suits should fit comfortably over the gymnasium costume or other sports attire but with-

2 United States Office of the Quartermaster General, *Supporters, Athletic,* June 7, 1945, pp. 3–4.

out losing a neat trim appearance when they are worn in place of gymnasium shirt and shorts. A suit consists of shirt and pants styled the same for both men and women, but cut according to the varying measurements for each sex. Shirts usually have rib-knit collars, cuffs and waistbands of the same or contrasting color to the rest of the garment. Necklines are round and, if provided with a collar, may be opened or closed. Slide fasteners are preferable to other types of closings.

Pants with lined waistbands with loops for belts and a fly front are less desirable, since suits may be put on and removed several times during practice or a game and adjustment of a belt is time consuming. Pant legs should fit close to the ankle. The trouser style with cuffs hampers activity and is a safety hazard that may cause a player to trip or fall. Close fit is obtained by use of a rib-knit cuff, sometimes elasticized, or slide fastener closings.

For the greatest amount of warmth and moisture absorption wool suits are ideal. Cotton flannel, used as a lining in suits of other fabrics is also effective for these purposes and is nontoxic. Top quality suits are lined with a napped fabric and have a durable outer fabric. Nylon and cotton flannel combinations are ideal since the nylon is strong, has excellent abrasion resistance and low moisture absorption. For similar purposes, rayon with a cotton napped lining is serviceable. Rayon and mercerized cotton with a sateen construction have a showy appearance. All-cotton suits are much cheaper than the other fabrics mentioned, and may be suitable for sections of the country where extreme cold is not a factor, as well as for early fall and spring practice.

Jackets

The usual athletic jacket worn for gymnasium activities is similar in fabric, color and construction to a warm-up shirt, but has a full-length front closing. Armholes may have a rib-knit insert, and necklines are a modified V shape with or without a collar. An extra charge is made for items such as slide fasteners, body and sleeve lining, gussets, striping and other similar features.

Hose

Short, ankle length, knitted socks in solid colors are worn for sports activities. Wool is the most widely used fiber because of its excellent moisture absorbing property. Wool and cotton, and more recently wool and nylon blends or combinations are proving effective. Cotton socks are cheaper and may be preferred by players who

are allergic to wool. Ribbed tops provide snug fit for the ankles. Hose should always be worn, regardless of the activity, as a matter of good personal hygiene, and protection against chafing and blisters. If colored hose are worn, the permanency of the dye should be assured. Cotton hose should be medium to heavyweight for durability. Socks increase in cost according to the quality, type fiber and weight of the hose in the order listed: heavyweight cotton, medium weight wool, heavy wool.

Shoes

Tennis shoes (canvas tops, rubber soles, heel-less) are usually worn for all-around gymnasium classes. Players who have weak ankles may prefer a high topped shoe that laces above the ankle. A low leather shoe is worn for gymnasium work (apparatus, stunts and tumbling, and similar activities). In the case of shoes a real safety problem exists. Tennis shoes are slippery and therefore dangerous when worn on a grass field in damp or rainy weather. Tennis shoes should not be used for field hockey, soccer, or speedball since they do not provide enough support and protection for the foot. Flat-soled (or rubber cleated) shoes with leather uppers are preferable for games involving kicking. Cleated shoes with canvas upper are worn for field hockey.

Tank Suits

Choice of a tank (pool) suit for use in school and college where suits are usually supplied, cleaned, sorted and stored by the institution presents a number of problems. Before selection is made, the purchaser must consider:

1. Chlorine content of the pool and the method of suit sterilization. Suits must be resistant in both fabric and color to the chlorine content of the water and the sterilization process.
2. Styling in terms of the age and sex of individuals using the suits, current style trends, laundry and storage facilities.
3. Use of suits for class or speed swimming.
4. Number of individuals using the suits and facilities for laundering, drying and storing. It is advisable to have on hand sufficient suits for any two days' use in case suits do not dry in time for use the next day. If suits are needed for swimming on week-ends, provisions for a three days' supply should be made. Thus, suits would be available for Friday, Saturday and Sunday.
5. Budget.

6.. Outdoor or indoor use, or both in terms of color resistance to sunlight.

7. Nature of water in which suit is used—fresh or salt.

FIBER, FABRIC, COLOR. At the present time the concensus is that the usual chlorine content of swimming pools does not affect any of the major fiber types if the suit is washed out soon after use. However, the effect of an increased amount of chlorine that is occasionally necessary due to a rise in bacteria count has not been ascertained scientifically and is a problem that warrants further study.

The effect of sterilization on fabrics is known, in general, and good quality cotton suits have so far stood the test better than any other fiber. Again, there is need for scientific testing in both laboratory and field of the degree of heat necessary to thoroughly sterilize suits and the effect of various types of sterilization. One suit manufacturer recommends that sterilization be done by means of live steam only, not by chemicals.

Cotton has been and continues to be the most widely used fiber for tank suits, but wool suits have been popular, partly due to their warm feel when damp. In old or poorly constructed filter systems, there has been the complaint that the wool fibers clog the drains. Wool is also very sensitive to hot water and high temperatures, and may shrink badly. The use of finishes that reduce shrinkage of wool to a minimum should be observed for their application to and effect on swim suits.

Rayon is sleek, smooth and excellent for speed swimming. It is much less durable than cotton in tank suits, and, especially in the case of acetate rayon, cannot be subjected to very hot water. Rayon suits may require ironing and are comparatively expensive.

Nylon, in addition to light weight, strength and excellent abrasion resistance, has the quality of quick drying. All other things being equal, this makes it an excellent fiber for use in suits since provision for slow drying is not a factor in the amount ordered and therefore fewer suits are needed. Nylon suits feel cold on the body and are comparatively expensive. Both nylon and rayon suits are very form fitting and cling to the body contours. Nylon knit does not have the elasticity of the cotton knit. Orlon suits have a better hand than those made of nylon but are also not as resilient as a cotton knit. Other properties of orlon suits are similar to those described for nylon.

Suits made from covered rubber thread provides a snug, trim fit. According to reports from several sources, these suits do not stand up well, especially in the sterilization process. They are also more

expensive when compared to suits of similar quality made from other fiber types.

Suits must be colorfast to laundering, to sunlight if used in outdoor pools, to chlorine, to chemicals if a chemical process of sterilization is employed, and to salt water in the case of acetate suits dyed with certain dyestuffs. Girls and women usually prefer gay, light shades. Large figures will look thinner in darker, less intense colors.

STYLE AND SIZE. Most tank suits commonly worn by girls and women in physical education swimming programs are one-piece, solid color, knit constructed (jersey), cotton suits (see Figure 74). The knit should be close and firm to prevent undue stretching and sagging. Reinforcement at the crotch gives increased durability in this section of the garment. Darts at the armholes contribute to better fit in this area. Vat-dyed colors are the most colorfast. The one-piece style is the most attractive for most girls and women and can be donned and removed quickly and easily. Suits that have a full or half skirt are more attractive on most figures than the skirtless style but are also more expensive. Sizes generally conform to bust measurements. Children's sizes range from 22–26; suits for girls and women range in size from 28–46.

There is great leeway in the requirements concerning pool suits for men. In a number of institutions students may wear their own suits, and all styles, colors and constructions are in evidence. Cotton trunks are worn by most boys and men. Fabrics are similar to those used in suits for girls and women. Racing trunks may be woven as well as knitted. A drawstring closing is the least expensive, most commonly used closing; some suits have a belted waistline, and the boxer style trunk with elastic waistband is also popular. Pants legs are cut on the diagonal and fit snugly. The latter style, combined with a lustrous rayon fabric, is used for speed swimming. Trunks are generally plain and solid colored. Some suits have a built in supporter. Sizes conform to waist measurement.

CHAPTER XVIII

Materials

MATERIALS

When buying equipment for physical education one of the greatest problems is to select that ball or glove or mat which will be the most durable. Durability, to a great extent, depends upon the type of material used in the manufacture of the equipment. Method of construction is a second factor. Persons who purchase athletic equipment usually have little or no experience in selecting types or judging qualities of materials. This is an important factor in securing durable equipment at reasonable prices. Included in the following pages are suggestions for judging and evaluating some of the more important basic materials—leathers, woods, plastics, rubber, light metals, and textiles.

LEATHERS

Next to textiles, leathers are the most important and most widely used of the basic materials in the manufacture of sports equipment. The amount used for athletic equipment is still increasing rapidly, due primarily to the increased interest in sports. There are many types of animal hides used in manufacturing sporting goods, of which calf, cow, horse, goat, sheep and kangaroo are most common. However, it is only when these hides have been tanned and finished that they can be called leather.

Some knowledge of the histology and chemical constituents of animal skins is essential to understanding leather. There are three layers of hide: epidermis, derma and flesh. Derma is the layer converted into leather; the other two are removed during the liming and tanning processes. All hides and skins are composed of a vast number of minute fibers, intricately interlaced. This structure gives the skin the necessary flexibility and strength. The variation of the fiber structure determines the resulting tensile strength and pliability of the leather produced from it, and the satisfactory preparation of skins for tanning depends upon the separation of these fibers without damage. The derma consists of connective tissues and fat cells in varied proportions in different skins. This determines the general characteristics of the finished product. Where large groups of fat cells are interspersed with collagen fibers (leather-forming fibers), the result will be the production of soft, spongy leather because empty spaces remain when the fat cells have been removed by tanning. In any good hide a concentrated collection of the collagen fibers is important since it is these fibers that determine the physical properties of the leather.

Unlike plastics, textiles and synthetic rubber, where the quality of the finished product can be controlled through chemical formulas, leather, basically, is a product of nature. The skins are composed of water, proteins, fatty substances, carbohydrates and mineral matter. The proportions vary according to the kind of animal and, in a given species, according to age, sex, mode of feeding, climatic conditions and method of killing. Further, in any one skin the texture varies from back to front and from side to side. Thus when selecting athletic equipment, one cannot order two dozen cowhide baseball gloves and be sure each is of exactly the same leather quality. In addition to variance in composition of the skins, standards for selection and grading of skins also vary. Perhaps one of the most needed operations in the athletic leather goods industry is a standardized procedure for selecting and grading animal skins.

Tanning

In preparing hides for leathers suitable for athletic equipment three tanning processes are most widely used: vegetable, chrome and alum. For all three processes the initial steps are the same. In the first stage of preparation hides and skins are restored to their original soft and flexible condition to facilitate handling. This is accomplished by soaking for a period of from one to seven days. In addition to making the skins pliable, soaking also washes out all

foreign materials from the hides. The second step is the removal of the hair and is usually accomplished by a liming process, started either by soaking in huge lime vats or by a tumbling action in large rotating drums. The limed skins then are dehaired. Since removal of the hair always leaves a distinctive surface pattern on the hide, it is the dehaired surface that is called the grain side.

VEGETABLE. Vegetable tanned leathers are produced by the action of certain tanning liquors or extracts from tree bark upon the fibers of hides and skins. By a suitable choice of tanning agents leather can be made which will vary in hardness, strength and flexibility. The principle of vegetable tanning consists of placing the hides and skins in tanning agents of progressive strength until every fiber has become permeated and tanned. This process normally requires two to six months.

CHROME. Chrome tanning differs completely from vegetable tanning. The hides and skins are placed in large tanning drums or rolls containing chrome chemicals, and through a rotating-tumbling action all the fibers are brought into contact with the tanning agents. Leather can be made from lightweight skins in five or six hours.

ALUM. Alum tanning, although not too important to the leather industry as a whole, is an important process in the manufacturing of leather athletic goods where white leather is required. Alum tanned leather is used for baseballs, softballs and volley balls, to mention a few.

Types and Properties

Strength, softness, durability, pliability and water-repellent characteristics are the qualities for which the purchaser should look when purchasing leather athletic goods. Strength and durability are important in all types of equipment; softness should be the primary requisite in items such as boxing gloves and binding on shoulder pads; pliability is especially important in the uppers of athletic shoes, and water-repellent features should be of the highest degree possible for such pieces of equipment as leather balls used outside and shoe soles. Each of the following types of leathers has one or more of these features in its natural state and the method of tanning may add more.

COWHIDE. In selecting skins for the production of heavy and durable leather (baseball gloves, shoes, footballs), the hide of the

steer or cow is usually used. Upward of 80 per cent of the total thickness of the hide consists of heavy interlacing bundles of collagen fibers, the chief leather-forming constituent of skin, and very few of the fat cells that tend to make leather spongy. These bundles of collagen fibers produce not only strength but also thickness and body. This is especially important for the sole leather of athletic footwear.

CALFSKIN. A calfskin appears much like a cowhide in miniature. Calfskins are used generally in making leathers where appearance of the grain is of some importance, especially for basketballs and volley balls. This is in contrast to the use of cowhides where weight, body and durability are the features most highly desired. Occasionally manufacturers will attempt to combine the good features of both the cowhide leathers and calfskin leathers by using kipskin, which is skin from an oversized calf not yet a matured cow.

SHEEPSKIN. The collagen, or leather-forming fibers, of the sheepskin are extremely thin and not closely interwoven. They tend to run parallel to the skin surface, causing a loose and spongy texture. Sheepskin is excelled in firmness, body, strength and durability by cowhide, calfskin, horsehide and kangaroo. Its chief virtue for athletic equipment lies in its loose, spongy texture, making it the best leather for boxing gloves and for the lining around the neck area on football shoulder pads. The covers for less expensive baseballs, low-cost baseball gloves and some footballs are made of specially tanned sheepskin. Sheepskin can be identified by its loose natural grain; it scratches quite readily, the leather feels spongy rather than tight or firm, and a strong pull will stretch it.

HORSEHIDE. The outstanding peculiarity of horsehide lies in the reticular layer of a very compact mass of dense collagen fibers. The compactness of the fibers provides a leather with high scuff-resistant qualities. However, the skin of the horse is much inferior to that of the steer or cow in qualities of strength, texture and thickness. This makes it undesirable for making sole leather. Most leather baseball covers and many baseball gloves and mitts are made of horsehide.

KANGAROO. Kangaroo skins are characterized by great suppleness, toughness and a grain several times thicker than the grain of any other kind of skin. The grain, after tanning, is very compact and resists the penetration of water and moisture. It will not crack or peel off as do some other skins. Because of the peculiar, closely intertwined fibers, this leather is the strongest known for a given weight

and thickness, seventeen times that of any other shoe leather. With a firm grain and a particularly satisfactory creasing quality, it is unexcelled for shoe uppers. In service it does not readily scuff, chip or crack. A peculiarity of kangaroo is the growth of hair follicles through the skin, leaving tiny holes that penetrate the leather and permit breathing. These air vents may easily be seen with the aid of a low-power microscope or hand glass.

There are two grades of kangaroo leather—yellow-back and blue-back,—each tanned by a different process. The best skins are tanned by the yellow-back process, producing a stronger, softer leather than the blue-back; the yellow-back leather is used exclusively for athletic shoes. Some blue-back skins are given a kid tannage, highly polished, for dress shoes, but the blue-back skins used for athletic footwear are given a special oil base tanning, making them more durable. Yellow-back kangaroo leather requires not less than six weeks to tan; blue-back requires about half that time. Kangaroo tanned by blue-back process retains much of its inherent strength and durability but is somewhat inferior to yellow-back. Genuine kangaroo is sold under that name. Kangaroo sides, kangaroo horse and kangaroo calf are *not kangaroo.*

ELK. Caution should be taken when purchasing any athletic equipment advertised or sold as elkskin. Elkskin is not genuine elk but only a trade term for cowhide of special tannage and finish. Genuine elk leather is designated by the term buckskin and any elk that is not genuine should be qualified as elk-finished cowhide or elk-finished kip.

Care

Care of specific items of leather athletic goods has been briefly described in the appropriate sections relating to that equipment. In general, keep the following in mind:

1. Keep leather goods as dry as possible, but when they do get wet allow drying to take place at normal room temperature. Mineral or vegetable oil will remove the harshness caused by drying.

2. Clean leather that has become soiled with saddle soap only. Never use any other type of soap or dry cleaning fluid. Apply the saddle soap with a moist cloth by rubbing the cloth over the soap to work up a cream on the cloth. Rub the soiled leather with the cloth until a lather has been worked up and the dirt is loosened. Wipe off the dirty lather with a clean cloth and rub the leather briskly with a clean cloth.

3. Green mold rot is the only harmful fungus to form on leather.

To prevent this, store equipment in a place with low humidity and normal room temperature.

Woods

Wood and lumber, although often used interchangeably, are not synonymous. Wood occurs in the veins of leaves and in various sizes and cylindrical shapes in bushes, shrubs and trees. Lumber applies solely to wood of considerable dimensions. There are two great categories of woods: soft woods and hard woods. It is the latter group of woods that are used most often in the manufacture of athletic equipment.

Identification

In identifying woods the physical properties may be divided into two categories: the mechanical and nonmechanical. Testing for mechanical properties, such as hardness, shock resistance and bending, requires technical skill and intricate equipment. The nonmechanical physical properties, such as color, luster and odor, do not require technical skills or elaborate laboratory methods. Many woods can be identified by these means when the manufacturing process has not destroyed such identifying marks. For example, a baseball bat made of hickory can be identified as such when the bat has been finished with a coat of clear lacquer or varnish. Such would not be true, however, if the bat was painted. Sometimes the weight of the wood can be of value in identification. Again using baseball bats as an example, it is quite easy to distinguish a hickory or ash bat from a willow bat—willow being only half as heavy per cubic foot as either of the other two.

Hardness also is used occasionally for identification, but strictly speaking hardness is not a nonmechanical property, for it requires a carefully measured stress for its determination. However, an idea of the approximate hardness can be ascertained by testing the wood with a knife or a fingernail. Hardness in wood and density are closely related and the dense woods are the hardest. Porosity reduces the density and decreases hardness. Listed below is a general classification as to hardness of the woods used most often in athletic equipment:

Very hard—hickory, osage orange, persimmon, dogwood
Hard—oak, beech, black walnut, yew, hard maple
Medium hard—birch, red gum, hackberry, soft maple, chestnut, elm, some of the ashes

Soft—willow, Douglas fir, hemlock, spruce, red cedar
Very soft—cypress, redwood

Defects

Rarely, if ever, does the consumer select the type of wood to be used in the manufacture of athletic equipment, but many of the defects found in the raw material are also found in the finished product. A knowledge of the most common defects and the ability to recognize them aids the purchaser in a better selection of athletic equipment made of wood.

BRASHNESS. Brashness is an abnormal condition that permits wood to break suddenly and completely across the grain, rather than splinter, under conditions where a normal piece of wood would not fail. Although there is no sharp visual demarcation between brash and normal wood of the same species, brash pieces can often be detected because they are abnormally low in density, and therefore do not have the hardness normally ascribed to that type of wood.

There are many causes for brashness—slow growth, abnormal arrangement of minute fibers called fibrils and compression wood, that is, wood taken from a leaning tree. Those defects, although very objectionable, cannot be detected by the lay person. However, careful attention should be given to any sign of decay. One of the most common causes of brashness is the prolonged exposure of the wood to high temperatures in kiln drying. Wood dried in a loft at room temperature over a period of months is much less likely to break clean across the grain.

Many baseball coaches and players believe this hurried drying process is mainly responsible for the generally low quality, the withdrawing of guarantees, and the high casualty rate of baseball bats, especially those that break completely across the grain in the critical area (the area starting 4 inches from the knob end and extending 10 inches along the barrel of the bat). Bat manufacturers, however, express the idea that abnormal breakage is a result of the small-handle models demanded by players and coaches.

KNOTS. A knot is the base of a branch or twig that is imbedded in the wood of a tree trunk or larger limb. The number, size and type of knots depend upon many features, such as the size of the tree, kind of wood and portion of tree from which the wood is taken. Because the knots cause a distinct change in the direction of the fiber, they weaken the grain and are likely places for splitting to occur.

SHAKES. A shake is the result of a rupture of cell tissues and cell walls during growth. It can be less than one inch or several inches in length. This defect weakens the grain and will cause further splitting. Such ruptures usually are circumferential openings between the annual rings.

FLECKS. A fleck is usually confined to hardwood. It usually appears as a small round or lunate-shaped area of wound tissue and is usually darker than surrounding tissue. Along the grain, in a baseball bat or hockey stick, the flecks appear in dark streaks of varying length.

CHECKS. A check is a small break caused by too rapid and unequal shrinkage. It always runs perpendicular to the grain.

WARPING. Warping is always the result of unequal shrinking or swelling. Great stresses are set up during the drying process and the cell walls become thinner and contract as the moisture is removed. Temperature changes, regardless of extremes, have little effect upon the size or volume of wood unless there is a change in moisture. Linseed oil, shellac, varnish or paint when applied in coats to the surface of the wood, form an almost airtight covering through which moisture passes very slowly. Under such circumstances, there is almost no warping.

Types and Properties

At least thirty-five different kinds of wood, totaling well over 25 million board feet, are used annually in the manufacturing of sports equipment. Table 18 shows the comparative properties of many woods. Below are brief descriptions of the sixteen woods used most often.

ASH. More than 5 million board feet of ash goes into athletic equipment annually. Most of it is used for baseball and softball bats. Ash is slightly under the average weight and hardness of hardwoods, but of much more than average strength and stiffness. It is a grayish brown, brown or pale yellow streaked with brown wood somewhat lustrous without characteristic odor, straight-grained, high in shock resistance, with excellent bending qualities, and holds its shape well even under the action of water.

BASSWOOD. With the possible exception of willow and cottonwood, basswood is the lightest, softest, weakest and least tough of

Table 18

COMPARATIVE STRENGTH PROPERTIES OF WOODS[1]

Type	*Weight per cubic foot (in pounds)*	*Bending strength*	*Compressive strength (lengthwise)*	*Hardness*	*Stiffness*	*Shock resistance*
Ash, white	42	113	106	107	168	153
Basswood	26	61	62	31	126	54
Beech, blue	48	76	66	116	114	296
Birch, yellow	43	106	98	86	174	171
Chestnut	30	68	70	50	112	69
Dogwood	51	100	101	154	124	192
Elm, rock	44	106	97	104	148	189
Gum, red	34	86	77	60	134	99
Hackberry	37	76	72	74	108	145
Hickory	48	126	105	114	165	308
Maple, bigleaf	34	83	86	73	132	78
Oaks, commercial red and white	45	100	92	105	161	134
Persimmon	52	122	116	162	172	136
Poplar, yellow	28	71	68	40	135	58
Cedar, Port Orford	29	82	90	48	168	79
Douglas fir	31	80	90	58	159	72
Hemlock, western	29	74	84	50	144	73
Pine, Norway	34	85	91	46	163	84
Pine, western white	27	69	75	35	137	65
Pine, western yellow	28	65	69	41	112	58
Spruce, Sitka	28	72	75	44	144	76
Yew, Pacific	44	115	112	138	121	170

the hardwoods. It is fairly stiff, has an even grain, a clear white color and is easy to work with. Only about 325,000 board feet is used annually, mainly on boats.

BEECH. Beech is a moderately hard, strong, heavy, close-grained hardwood. Its wear-resisting qualities are very desirable. Approximately 212,000 board feet is used annually for baseball bats, croquet balls, table tennis paddle handles, skate wheels and tennis racket handles.

BIRCH. About 1 million board feet of black and yellow birch is used each year, for such items as billiard and pool tables, playground equipment, skis, sleds and toboggans. Both kinds of birch

[1] *Comparative Strength Properties of Woods,* Technical Bulletin 158.

are heavy, of average hardness, stiffness and strength for hardwoods, and are above average in toughness. Birch takes a fine polish and often has a beautiful grain. Its hardness makes it especially wear resistant.

CEDAR. Of the many types of cedar, white cedar is the one of most interest to manufacturers of athletic goods. It is perhaps the lightest, weakest and softest American wood which is cut in large quantity, but its durability is very high. Because of its lightness and ease of working, white cedar has been a popular wood for canoes and small boats and also for tennis racket handles. Most of the top quality wood arrows are made of Port Orford cedar.

CHESTNUT. The wood of chestnut is rather light, soft, straight, coarse-grained and durable. It is easily worked and used most often for sides of billiard and pool tables.

ELM. White elm is among the lightest of the hardwoods in weight, not so strong as many of them and not very hard. It is, however, a very tough, fibrous wood. Because of its toughness and susceptibility to bending, elm is used for bobsleds. Over 3½ million feet is used annually.

HACKBERRY. This wood is heavy, moderately hard, strong and tough. In properties it is most like white elm, while in appearance it resembles ash. For that reason, hackberry is frequently used for baseball and softball bats. It is pale yellow to grayish or greenish yellow, has good bending qualities, straight or sometimes interlocked grain, is moderately weak in endwise compression, high in shock resistance, and fairly free from warping.

HICKORY. With the exception of black locust and osage orange, hickory is the heaviest, strongest and toughest of the native woods of the United States. It is the remarkable toughness and the ability to withstand shock that make it useful for such equipment as baseball bats, golf club handles, trapezes and ski poles. It is pale brown to brown or reddish brown, straight-grained, exceedingly strong in bending and endwise compression, exceedingly high in shock resistance, and low in ability to hold its shape.

MAPLE. Maple is of moderate weight for a hardwood, strong, hard and has good wearing qualities. Baseball bats, billiard cues, tennis and badminton racket handles, croquet balls, and bowling pins frequently are made of maple. About 5 million board feet goes into the production of these articles each year.

OAK. Oak is heavy, hard, strong and tough. Some of it is used for bats, parallel bars, racket handles and sleds. It is rich light brown to dark brown, usually straight-grained, strong in bending and endwise compression, high in shock resistance, and splits easily.

OSAGE ORANGE. This is the heaviest, hardest and toughest American wood, but in strength and stiffness it is somewhat surpassed by black locust. Osage orange is one of the most durable woods and is used extensively for archery bows. It is golden-yellow to bright-orange, darkens with exposure, often has reddish streaks along the grain, has coloring matter readily soluble in tepid water, and is straight-grained.

PERSIMMON. Persimmon is fine-grained, very heavy, hard and strong. It takes a high polish and is extremely resistant to wear. Over one thousand cords of persimmon are used in the United States annually in the manufacture of golf club heads. The sapwood is white to grayish white, heartwood blackish brown to black, often streaked, irregular in outline, high in shock resistance, and does not glue well.

WILLOW. The wood from a willow is very light and soft, and while neither stiff nor strong, is tougher than many heavier woods. Fungo bats for baseball are usually made of willow.

YEW. Yew is bright rose to orange-red, even-grained, fine-textured, heavy, hard, especially strong in bending and endwise resistance, and of limited commercial importance because of scarcity and small size. Many top quality archery bows are made of yew.

YELLOW POPLAR. This is a light, soft, fine-grained, easily worked and quite durable wood. It is used for laminated racket handles and bowling alleys.

Care

Moisture is one of the main sources of difficulty in the care of equipment manufactured in whole or in part from wood. A surface coating, such as aluminum paint varnish or lacquer, is one of the most effective moisture excluding finishes for wood, but is easily worn away by mechanical wear and tear on wood that is subjected to contact with other objects such as balls and sticks. Therefore, linseed oil, a sealer type of finish is recommended for this type of equipment. The oil penetrates the wood rather than remaining on top of it and does not soften the grain of the wood or weaken it for

contact with other equipment. For best results apply hot linseed oil; it will penetrate deeper and last longer. Renewal of this treatment every two weeks, especially if the equipment is buffed well each time, will keep this sealer finish in good condition.

Wax is a polish, not a coating. It is used to give the wood a fine gloss or to make the surface slippery (as in the waxing of skis). It can always be used over an oil or sealer finish and renewed as often as desired.

It is frequently possible to remove small dents from wood by moistening the dented area with warm water. Allow a few minutes for the water to swell the dented wood, and then apply enough heat to the local areas to dry out the moisture again.

Store wood equipment in a place where temperature and relative humidity will be both moderate and as nearly constant as possible. Avoid extremely high and extremely low temperatures and relative humidities. In very hot dry climates keep the equipment between times of use in the coolest practicable place or in a place where the relative humidity can be kept to a point at which there will be no material drying out at the prevailing temperature. Mr. J. N. Tynan, a specialist in the production and care of athletic equipment manufactured from wood, advises as follows:

> Storage of all athletic equipment would be improved if an air-conditioned room could be made available to maintain constant temperature and humidity, say 70 to 75 degrees and 50 to 60 per cent humidity. This condition would be ideal for the preservation of maximum tensile and impact strength of sports equipment made from wood, fiber, fabric, etc. and this controlled condition plus constantly cleaned equipment would be the ideal method of storage. Metal equipment stored under these conditions and either painted or plated should be simonized or waxed to retain its original finish.

Plastics

Some twenty or more separate types of plastic compounds are being manufactured in the United States. From many of these types at least thirty-five pieces of sports equipment are being produced. Plastics as a basic material for use in manufacturing are comparatively new—only since 1929 have they been used. Nearly all manufacturers of sports equipment are experimenting with this new material, and, according to most, plastics have opened an entirely new field in athletic goods.

Types and Properties

There are many resinous materials which, by the application of heat and chemicals, can be shaped or molded to a desired form. These many plastic materials are divided into two groups: thermoplastic resin and thermosetting resin.

THERMOPLASTICS. This is the group which remains as a solid only when the temperature is within certain definite limits. Depending upon the materials, any temperature above 110 degrees may melt the substance and cause it to flow. This is important both to the user and to the manufacturer. For the latter it means that the rejects and scrap materials can be melted and reused. Included in the thermoplastic group and used in sports equipment are the following:

Cellulose nitrate plastics, one of the oldest of plastics, are used primarily as a protective covering on fishing rods and some golf clubs. They are easy to color, noted for toughness and resistance to wear and for water repellent characteristics. However, they are inflammable. Common trade names include Celluloid, Pyrolin and Amerith.

Cellulose acetate plastics are produced by treating cotton with acetic acid. They are extra tough, very high in breaking strength, transparent, translucent, can be utilized in very thin sections and are not inflammable. Many molded plastic football helmets are made of cellulose acetate plastics. Common trade names include Plastacele, Tenite I and Bakelite Cellulose Acetate.

Cellulose acetate butyrate plastics are very similar to the preceding type. However, they mold easier and have good weather resisting qualities. Gun stocks and molded football helmets are among the items of sports equipment manufactured from this type. Tenite II is a very common cellulose acetate butyrate plastic.

Ethyl cellulose, a fourth type of cellulose plastics has all of the qualities of the preceding types, except that it can be used in laminations instead of being molded. Many laminated plastic helmets are made from this type. Also experimental work is being done on golf club heads (woods). Dow Ethocel and Hercules Ethylcellulose are some of the commercial names.

Vinyl plastics. Of this series, vinyl acetate is the most widely used for athletic equipment. It is nontoxic, usually noninflammable, non-

warping and has a very high resistance to water absorption. Rolled edge bindings of football helmets are of vinyl. Experimental inflated balls have been made of vinyl-coated fabrics and golf bags are made of vinyl sheeting. Vinylite is one of the outstanding plastics in this field.

THERMOSETTING PLASTICS. This group of plastics is found in the original state as a thermoplastic, but when chemicals are added and heat applied the material tends to set like cement. After this reaction heat will have only a slight effect on thermosetting plastics. Phenol-formaldehyde, better known as phenolics, is rapidly gaining a place in the manufacture of sports equipment. Among the present uses are football thigh guards and kidney pads, soccer shin guards and injected molded caps for golf club handles. Phenolics, because heat has only a minor effect on them, can be injection molded under heat rather than by the slower molding process used for thermoplastics. Phenolics have many of the good qualities of other plastics —strength, toughness, low cost; but their main feature is ease of molding under heat and pressure. Some of the common trade names include Bakelite, Catalin, and Micarta.

Care

Of all the basic materials used in sports equipment plastics probably need the least amount of care, but, unlike the other basic materials, they are often more difficult to repair. All plastics may be cleaned with water. Some items, such as football helmets, need extra precaution if maximum wear is to be attained. Plastics need no special type of storage.

Rubber

The most important underlying development of the rubber industry was the discovery of hot vulcanization of rubber in 1839 by Charles Goodyear. Another important development was the art of compounding—blending crude rubber with various mineral powders, oils, fibers and other materials to secure special properties of the finished product. These two discoveries gave rise to a new era in sports equipment.

Types and Properties

Two types of rubber are used most extensively in the manufacture of athletic goods: vulcanized and foam. Cold rubber, a third

type now going through the experimental stage, may eventually supersede the other two. All types have one or more of the special properties necessary in the manufacture of athletic equipment: resistance to abrasion, flexibility, elasticity, absorption of shock, impermeability, quality of being waterproof, resiliency, and high frictional resistance.

Flexibility, when combined with one or more other desirable properties, renders some rubber athletic goods superior to those of other materials under certain conditions. Foam rubber padding is more flexible than kapok or fiber. Elasticity of rubber has caused it to be used extensively in elastic webbing for athletic supporters and in bladders for inflated balls. Absorption of shock is a valuable property of foam rubber where it is used for protective padding as in helmets and on pads. Sponge rubber does not absorb the shock impact as well as foam rubber. Resistance to diffusion of gases applies to foam rubber where each little cell is an air-tight chamber. This property is equally important when vulcanized rubber is used in bladders for inflated balls and in tennis balls. Waterproofness of vulcanized rubber has long been recognized, but only in the last decade has it been applied to athletic goods. A rubber-covered water polo ball is gradually replacing the traditional leather-covered ball; and many schools and some colleges are using the rubber-covered football for class activities, intramural games and varsity games played in the rain or on wet fields. The same is true for soccer and softball. On dry surfaces, rubber has a very high frictional resistance; consequently it is used for rubber-soled athletic shoes. Without resilience, an important property of rubber, the flight distance of golf balls, tennis balls, handballs, and to some extent baseballs would be decreased. A brief description of the three types of rubber follows.

VULCANIZED. Through vulcanizing strong rubber bladders for inflated balls, solid rubber cores for baseballs and golf balls, durable hard rubber cleats for football shoes, rubber soles for athletic shoes, and abrasive, resistant covers for rubber-covered balls are made available for sports equipment. By skillful compounding of rubber with other materials, vulcanized rubber can be varied to meet a great diversity of conditions of durability and performance. One of the outstanding properties secured in vulcanized rubber is its resistance to abrasive wear. During the past few years this has been utilized in rubber-covered inflated and yarn-wrapped balls.

FOAM. Foam rubber is a recent addition to sports equipment and is gradually supplanting kapok as a means of protection and safety

when used in pads and helmets. To produce foam rubber, liquid latex is beaten until it resembles whipped cream. A chemical agent is added to form bubbles, the rubber is poured into molds, and the air bubbles are frozen into the mixture to make it fluffy but sturdy. The minute rubber walls around each bubble become vulcanized and foam rubber becomes a mass of tiny rubber balloons, all permanently stuck together.

Foam rubber maintains its resiliency much longer than sponge rubber and does not mat or shift, as does regular loose padding such as kapok. As used in sports equipment, the resiliency and the corresponding shock absorbing qualities depend upon use and wear. When new, foam rubber is highly shock absorbent (more so than kapok), and because of the minute vulcanized walls it is waterproof. Some football coaches report that foam rubber when used in hip pads, shoulder pads and helmets, loses much of its life; that is, it becomes flat and water absorbing after a short period of time. This condition is due to the rupturing of the vulcanized cell walls, allowing the air to escape and permitting water or perspiration to seep in. The rupturing or breaking down of the cell walls is caused by the continued flexing and shock waves which result from body contact through tackling and blocking.

At present, the difficulty of transporting liquid rubber and the newness of processing methods make the production of foam rubber fairly expensive, and it is used only on the more expensive pieces of equipment. Rubber engineers feel that when production costs are reduced, foam rubber will be used on nearly all types of protective athletic equipment. Constant research is being undertaken in an effort to strengthen the minute cell walls without increasing the weight. At present foam rubber is marketed in sheet form of various sizes 16 inches square and up. It can be purchased in ½, ¾ and one inch thicknesses, and in three densities: soft, medium, and firm. For athletic protective covering the one inch thick, firm type is considered best.

COLD. Recently a third type of rubber processing has been developed, resulting in a new product called cold rubber. It is a synthetic rubber and labortory tests thus far indicate that its wearing qualities, especially resistance to abrasion, are about 30 per cent greater than those of natural rubber. As yet cold rubber has not been used in the manufacture of sports equipment, but it is expected that after further refinements it may be a new and important basic material in this field.

Care

Heat and light are the two greatest deteriorating agents which work upon rubber. Keep rubber-covered equipment indoors when not in actual use. Store all items made of rubber in a cool place. Use a damp cloth or water for cleaning. No cleansing agents such as dry cleaning fluid, gasoline or alcohol should be used. Foam rubber may be washed, but dry it where the air is circulating freely.

Light Metals

Although they may be one of the important basic materials of the future, alloys of light metals are still in an experimental stage for athletic equipment. Especially is this true in such sports as baseball, where the Official Baseball Rules Committee restricts any other type of bat than that made from wood in one piece.

Types and Properties

Those who favor the use of light metals such as aluminum, magnesium and their alloys, cite several advantages for their use in sports equipment: strength, light weight, permanence and excellence of finish, safeness and durability. Items of sports equipment made of alloys, other than aluminum vaulting poles and magnesium baseball masks and bats, have not been discussed previously because of their limited use. There are several designs of alloy tennis racket presses. Those who favor them do so on the basis of lightness and ease of use. Some aluminum tennis rackets were made, but did not achieve any degree of popularity because of failure to obtain correct balance and feel. Also some models, when used consistently on one face only, tended to bend slightly. A recent model has been made of bent tubing and wire strung in an effort to prevent any bending. A recent patent (Number 1,994,069) relates to a special design of shaft suitable for sports equipment. It is aimed at increasing stiffness of the shaft to a desirable point without raising the weight. The device is adaptable to all racket games, golf and baseball.

Aluminum tennis nets are available, but their cost is well above that of the traditional type. The advantages claimed for the aluminum net are these: it is more durable, can be left out in any weather, will not sag, and can be seen more easily.

The first aluminum golf club was made in 1914 in England. Some aluminum clubs are being manufactured now but are not especially popular. According to many people construction of such clubs other than putters is not justified. Since weight and balance are the prin-

cipal requirements, the low density of the metal is of no advantage. Others say that softness and lack of rigidity make it feel dead. There is a trend toward using alloys in the manufacturing of lightweight caddy carts.

One bat manufacturer claims that no matter how a magnesium bat is held, the bat does not sting or will not break in actual use. Aluminum or magnesium bats are more expensive than those made of wood. The present models are from 32 to 34 inches long, and weigh 32 and 33 ounces. Unlike tennis rackets, which bend slightly under hard usage, baseball bats are rarely hit on the same face by consecutive batters. Consequently, the impact area is distributed over the entire hitting surface.

Implements for field events have been made from alloy metals and meet all of the Amateur Athletic Union and other rules committees' specifications for size, shape and weight, but do not comply with the restrictions as to materials used in construction.

Except in those cases where there have been enough field tests or laboratory tests from which to draw valid and reliable conclusions, it is difficult to compare performance, durability and serviceability of items of athletic equipment made of light metals with those manufactured from the more traditional materials.

Care

Equipment made of light metals needs little care. A light coat of oil should be applied before off season storage.

Textiles

Each of the major textile fibers used in sportswear differs in nature and in specific fiber properties. In natural fibers, properties are the result of a combination of the efforts of nature and man. In the development of man-made fibers, especially synthetics, an absolute control of certain properties is possible. In sportswear, more than in the case of any other type of clothing, working clothes excepted, the reactions of fibers and fabrics is very important, since the nature of vigorous activity places great demands upon the clothing worn for the activity. Reaction to stress and strain, cleaning and laundering, sunlight, perspiration, moisture and dyes are but a few of the factors that must be taken into consideration when a choice of fiber and fabric is necessary.

Some generalizations can be made concerning the reactions of all fibers;

1. Prolonged exposure to sunlight weakens all fibers except acetate rayon.

2. Strong bleaches, including chlorine, if used for long periods and in very hot temperatures, are injurious to all fabrics.

3. All fibers are subject to attack by moths and certain insects.

4. All fibers can be produced in varying degrees of luster. Nylon is still in the experimental stage with development of fabrics that have a dull luster.

5. All fibers can be made into fabrics that range in weight and texture from very light and sheer to heavy.

6. All fibers can be varied in texture from soft to rough and other types of handle. (The terms handle and hand are synonymous and describe how the fabric feels. A fabric, for example, may be said to have good body or to be too light, and similar characteristics related to handle.)

7. Garments made from any fiber type should be washed or dry cleaned (depending on the fabric) after they have been subjected to perspiration since perspiration is usually injurious to the color of any fiber.

8. All fibers are injured by certain strong acids especially if subjected to these acids for long periods of time and at high temperatures. The type of acid that is injurious varies for each fiber type, but caution is advised in dry cleaning and spot removal.

9. All fiber types are selective in their affinity to dyestuffs and to particular shades and colors of these dyestuffs.

Cotton

Cotton, like wool, has been a staple fiber for sports clothing for many years. In contrast to the wool, cotton is a cool fabric. Hardly a sports garment worn in warm weather is not available in a cotton fabric. Cotton is also used in some winter sports apparel, and combined with wool and other fibers, cotton sportswear can be worn the year around. Table 19 lists some of the uses of cotton in sports clothing and equipment.

Cotton is a vegetable fiber that grows in plant form throughout many parts of the world, including the southern and southwestern sections of the United States. The quality of the basic cotton fiber varies with the part of the world in which the cotton originates. Quality is determined also by fineness, staple length and grade, including color, absence of foreign matter, and method of preparation. Best quality fibers are imported from Egypt, or grown in the western

Table 19

THE USE OF COTTON IN SPORTS CLOTHING AND EQUIPMENT

Fabrics	*Clothing*	*Equipment*
Airplane fabric	*Specific use*	*Nets and net tapes*
Balloon Cloth	Gymnasium shorts and shirts	Tennis
Batting	Field hockey tunics	Badminton
Bedford cord	Basketball shirts	Basketball
Broadcloth	Riding coats and pants	Lacrosse
Chambray	Ski suits	Volley ball
Corduroy	Swim suits and trunks	*Covering, batting, webbing*
Crash	Softball knickers	Football pads (kidney, knee and other pads)
Denim	Towels (pool and beach)	Boxing gloves
Drill	Warm-up shirts and shorts	Baseball bases
Duck	Footless athletic stockings	Softball bases
Elastic yarn (woven and knit)	Track shirts, shorts	Umpires' chest protectors
Flannel	Hunting clothes	Catchers' chest protectors
Gabardine	Trimmings	Basketball pads (hip, knee)
Gingham	*General use*	Shin guards
Holland	Sport shirts	Gymnasium mats
Honeycomb waffle	Sport jackets	*Bags*
Jean	Sport skirts	Ball carrier
Jersey	Sport dresses	Duffle
Khaki	Sport slacks, culottes, shorts	Sleeping
Knitted fabrics	Sport hose	Golf
Madras	Sport hats	*Linings (fabric) for balls*
Middy twill	Play suits	Volley balls
Muslin		Basketballs
Nainsook		Soccer balls
Osnaburg		Footballs
Oxford		*Windings, stitching on balls*
Pique		Baseballs
Poplin		Golf balls
Sateen		*Shoe uppers*
Terry cloth		Tennis
Whipcord		Gymnasium
		Basketball
		Tents
		Back stops
		Fishing twine
		Shoestrings
		Thread for sewing

section of the United States, notably Arizona. This latter type is known as Pima cotton. Sportswear advertised as manufactured from Egyptian or Pima cotton is usually of top quality construction, since these fine cottons are rarely found in lower quality merchandise.

Covered Rubber Thread

The number of items of apparel in which covered rubber threads are used is growing daily. The outstanding elasticity of rubber makes it uniquely suitable for all clothing in which a snug, trim fit is essential, and where flexibility and ease of movement are equally important.

The natural rubber used in these threads is secured from the milk of the rubber tree and is used almost exclusively as it is superior to synthetic rubber in most properties required in clothing and equipment. Threads vary in the covering that is used. Any of the major textile fibers (wool, silk, cotton, linen, nylon, rayon) may be used as covering. Table 20 lists some of the uses of covered rubber thread in sports equipment and clothing. The covered rubber thread is itself a combination of rubber and the covering textile yarn.

Table 20

THE USE OF COVERED RUBBER THREAD IN SPORTS CLOTHING AND EQUIPMENT

Fabrics	*Clothing*	*Equipment*[2]
Knitted fabrics	*Specific use*	*Webs and braids on*
Woven fabrics	Football pants	Chest protectors
Woven braids and webs	Boxing shorts	Masks
	Riding breeches and jodhpurs	Shin guards
	Athletic supporters	Tennis shades
	Swim suits and trunks	Other similar items
	Warm-up suits	Lacings for balls
	General apparel	
	Sweaters (waistbands and cuffs)	
	Dresses	
	Slacks, culottes, shorts	
	Jackets	
	Hats	
	Shoes and shoe laces	

[2] A rubber thread is used as winding in softballs, baseballs, and golf balls, but this is not a covered rubber thread.

Nylon

The high durability of nylon fabrics makes them particularly suitable for activities that put great stress and strain on the garment. Nylon staple is providing such garments with the warmth traditionally associated only with wool. Two outstanding properties of nylon essential to efficient functioning of sportswear are the ease with which it is laundered and the resistance of the fabric to loss of shape and creasing. Quickness of drying and light weight are other outstanding advantages of nylon garments. In sports equipment whereever textile fibers are used, nylon is rapidly replacing many of the older fibers. This is due primarily to the great strength, elasticity, and general ability to weather the elements that is characteristic of nylon fabric. It is, therefore, particularly useful in equipment for sports conducted out-of-doors, especially items that are subjected to a good deal of rain and to long immersion in water, fresh or salt. Some other uses of nylon are indicated in Table 21.

Nylon is a true synthetic, the result of chemical processes. It varies in quality but the consumer cannot determine this fact unless advertising or a label gives this information.

A *small* amount of nylon blended with wool increases its strength and abrasion resistance, while a *larger* amount also gives the fabric satisfactory dimensional stability. It has been found, for example, that at least 65 per cent nylon must be added to 35 per cent untreated wool if socks are to retain their shape so that they do not need to be dried on stretchers. The speed of drying is not likely to be affected substantially. Nylon staple is particularly effective for this purpose. Nylon also makes possible a wool fabric that is lighter, more sheer and has greater dimensional stability than wool used alone. Nylon is also used to reinforce fabrics at critical wear points, as for example, the nylon heel and toe reinforcements in socks of other fibers. Continuous filament nylon and rayon yarns combine the draping qualities and hand of rayon along with the strength, abrasion resistance and washability of nylon. The addition of rayon to nylon makes possible a fabric that can meet price levels of other similar fabrics, since the cost of an all-nylon fabric is still considerably higher than many fabrics constructed from other fibers. Nylon combined with cotton increases the strength and abrasion resistance of the fabric and at the same time the softness of the cotton fiber is retained.

Table 21

THE USE OF NYLON IN SPORTS CLOTHING AND EQUIPMENT

Fabrics	*Clothing*	*Equipment*
Elastic yarn (woven and knit)	*Specific use*	*Racket stringing*
Knitted fabrics	Uniforms	Tennis
Poplins	Basketball	Badminton
Satins	Baseball	Squash
Taffetas	Football	*Twine, thread, rope*
Twills	Fishing jackets	Fishing lines
Velvets	Golf jackets	Mooring lines
	Skating costumes	Fish nets
	Ski suits (suits, caps, parkas, gloves)	Tennis nets
	Swim suits and trunks	Thread for sewing
	Warm-up shirts and pants	Lacrosse stick nets
	General use	Rope for mountain climbing
	Sport shirts	*Inner linings for balls*
	Sport jackets	Basketballs
	Sport skirts	Footballs
	Sport dresses	Volley balls
	Sport slacks, culottes, shorts	*Tarpaulins*
	Sport hose	Baseball diamonds
	Sport gloves	Outings
	Sport hats	*Bags*
	Snow suits (children)	Golf
		Beach
		Covers for golf clubs
		Tents
		Sleeping bags
		Inflatable boats
		Sails

Rayon

The high luster of rayon filaments has made this textile very popular in sportswear when a brilliant, shiny appearance is desired. The smoothness of rayon fabrics is also well suited to apparel for those sports in which it is desirable to have a minimum amount of friction and a smooth surface that makes the garment difficult to grasp. Some of the uses of rayon in sports attire is indicated in Table 22.

Table 22

THE USE OF RAYON IN SPORTS CLOTHING

Fabrics	*Clothing*
Acetate crepe	*Specific use*
Acetate Panne satin	Gymnasium shirts and shorts
Acetate sharkskin	Football jerseys, pants
Basket cloth	Basketball shirt, pants
Broadcloth	Softball jerseys
Covert	Warm-up pants
Elastic yarn (woven and knit)	Boxing trunks
Flannel	Track pants, shirts
Gabardine	Footless athletic stockings
Hopsacking	Ski wear
Jersey	Riding habits
Knitted fabrics	Swim suits and trunks
Linen-textured rayon	Trimmings; letters
Mesh	*General use*
Pique	Sport shirts
Satin	Sport jackets, linings
Seersucker	Sport skirts
Serge	Sport slacks, culottes, shorts
Suiting	
Twill	
Tackle twill (rayon and cotton)	
Tricot	
Tweed	
Whipcord	

Rayon is a man-made textile fiber manufactured from a cellulose base. The process used in the manufacture of acetate rayon differs from that used for the other two types—viscose and cuprammonium—and the reaction and properties of acetate may be decidedly different. This is confusing to the consumer who purchases rayon products unaware of these differences and of the special types of care required by the two rayon types. Attempts are being made to have acetate rayon designated as Estron. As further guides to buying remember that rayon must be designated as rayon in invoices, labels, advertising and all other disseminated or published statements. Trademarks may be used provided the word rayon is included in the description as, for example, Bemberg Rayon.

Cotton added to rayon gives greater strength to the rayon fabric. Rayon contributes a softer hand and added luster to the cotton. Rayon provides a better hand for a nylon fabric and better draping quality, and may result in fabrics that are less expensive than all-nylon products. Fabrics constructed of rayon and wool have warmth and resiliency plus the sheen, draping quality and strength supplied by rayon. Fabrics may be washable depending on the amount of rayon used. Rayon gives a fuller hand to silk and minimizes static. Spun rayon combined with other textile fibers makes possible interesting textures and simulates fabrics made entirely from wool.

Wool

The preeminence of wool (and other animal fibers) in sports attire is due not only to the warmth giving property of woolen and worsted fabrics, but to their high elasticity and excellent moisture absorbing properties. It is a fallacy to consider wool fabrics in terms of winter wear exclusively. Wool shirts and hose are equally suitable for sports participation during warm weather, since, paradoxically, wool can be both warm and cool feeling. The amount and rate of moisture absorption and the use of lightweight fabrics makes this possible.

Table 23 lists certain uses to which wool is put, evidence of its widespread application to sportswear and equipment.

The term wool is used to describe fibers secured from the coats of sheep, camels, alpaca, llama and vicuna. All types are found in sportswear. Fibers vary in length, color, diameter, serrations per inch, fineness, resiliency, elasticity, and number of impurities present, all of which determine the quality of wool. Peculiar to wool fibers are the numerous minute scale-like formations on each fiber. These serrations cause wool to "felt" and assist the formation of air pockets that contribute to the warmth of wool fabrics. Fibers vary in quality depending on the type sheep from which the fibers are secured and the section of the animal from which the wool is clipped.

The Federal Trade Commission in the Wool Products Labeling Act distinguishes among three types of wool, namely, virgin, reprocessed, and remanufactured (reused) wool. Virgin wool has never been made into yarn or cloth; reprocessed wool has been fabricated, but never used by the ultimate consumer, and then reprocessed; reused wool has been used by the consumer and then returned to a fibrous state. The elasticity of the reworked fibers is considerably lower than the virgin wool fibers because of the over-stretching and pulling which occurs during the breaking operations. Consumers are frequently misled by the term virgin wool and consider it an absolute

Table 23

THE USE OF WOOL IN SPORTS CLOTHING AND EQUIPMENT

Fabrics	*Clothing*	*Equipment*
Alpaca	*Specific use*	*Covering* (felt)
Angora	Baseball shirts, pants, caps	Pool and billiard tables
Bedford cord	Football jerseys, pants, jackets	Tennis balls
Cashmere	Footless athletic stockings	*Padding in*
Cavalry twill	Field hockey tunics	Baseball bases
Cheviot	Gymnasium shirts, warm-up suits	Softball bases
Elastic yarn (woven and knit)	Riding habits	Baseball leg guards
Elastique	Ski suits	Baseman's mitts
Felt	Soccer uniforms	Catcher's gloves
Flannel	Swim suits and trunks	Shin guards
Gabardine	Emblems and trimmings	Boxing gloves
Gun club checks	*General use*	*Winding in balls*
Herringbone	Sport shirts	Baseballs
Homespun	Sport skirts	Softballs
Jersey cloth	Sport jackets	*Knitted practice balls*
Knitted fabrics	Sport dresses	Golf
Khaki	Sport slacks, culottes, shorts	Badminton
Melton	Sport sweaters	
Polo cloth	Sport hose	
Shepherds' check or plaid	Sport gloves and mittens	
Ski cloth		
Tweed		

indication of top quality. Due to the variations in quality of wool fibers, it is possible for reprocessed wool, and, in some cases, reused wool to be superior to virgin wool.

Fabrics manufactured from wool combined with cotton are cheaper than most all-wool fabrics. They are less warm also. However, it is an effective combination for those who are allergic to an all-wool fabric. Blends of virgin wool with reprocessed or reused wool may result in fabrics that are less expensive and more durable than all-wool.

Consumers can readily identify wool since every wool product must have some form of identification (label, tag, or other mark). Where the fabric or product in question is composed wholly of one kind of fiber, either the word "All" or "100 per cent" may be used

with the correct fiber name. If non-wool fibers are used as reinforcement of a wool product, the percentage of the non-wool fibers must be given. For example: "All reused wool except 20 per cent cotton reinforcement added to toe and heel."

Conclusion

The best solution to consumer problems in recognizing quality fabrics lies in the adoption and use of labeling. By this method the burden of proof, in the form of testing of fabrics for various properties, rests with the manufacturer and retailer. The consumer is spared the detailed research that is now necessary in order to be adequately informed.

APPENDIX A

Test Methods and Procedures

To indicate the type of work that has been developed by the United States Army Quartermaster in the area of testing athletic equipment, some examples of specific tests have been included here.

Workmanship

The item should be examined visually for evidences of poor workmanship which might affect serviceability and for poor appearance in general. The importance of this test varies widely with the article under examination, being less in the case of products for which tests have been established for the major functional properties, but primary in the case of athletic equipment for which functional laboratory tests are nonexistent.

Out-of-Roundness

Purpose: To determine deviation from true roundness.

1. Balls and bags

Striking bags	Volley balls
Golf balls	Water polo balls
Soccer balls	Baseballs
Softballs	Basketballs

a. Apparatus. Ames Dial Gauge, model 282, range of one inch or equivalent, equipped with a movable bezel.

b. Procedure. All inflatable items except striking bags are placed in the triangular support. All balls, except inflatable ones, are placed in the round depression. The dial gauge is placed so that the ¾ inch diameter presser foot is centered over the depression or support and also is horizontal. The gauge may be centered conveniently by holding a string attached to a plumb line at the center of the presser foot. The hand of the dial gauge is set at more than .5 inches when the ball is positioned so that it is free to move either way. After the ball has been placed in position the foot of the dial gauge is lifted gently to make certain the ball is seated firmly in the support, or

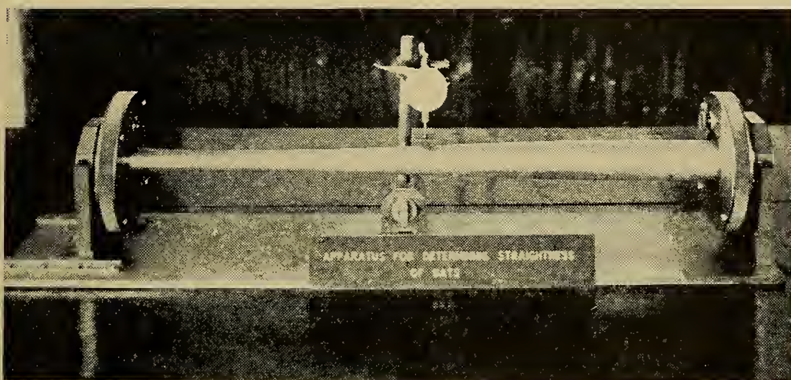

Figure 73. Apparatus for determining straightness of bats. (*Courtesy of United States Quartermaster Corps, Jeffersonville Quartermaster Depot. Plate number 1194–5.*)

otherwise it will rock. The reading is recorded. After this has been done at all the required positions, the minimum is subtracted from the maximum reading, and the difference recorded as the out-of-roundness. Care must be taken that such items as laced inflatable items, baseballs and softballs do not rest on laces or seams.

2. Bats

a. Apparatus: (see Figure 73). A dial gauge, Brown and Sharpe, equipped with triangular cross-section foot is used for measuring.

b. Procedure. The bat is placed in the jig so that it rests firmly on the V block. It is placed in one of the three positions indicated in the drawing. The presser foot is centered on the uppermost part of the bat and the dial gauge set at 0. The bat is rotated under the presser foot. The sum of the maximum minus reading and the maximum plus reading is recorded as the out-of-roundness. This procedure is repeated at each of the two positions indicated. The bat must rest on the two points of the V and not on one edge only.

Rebound

1. Spherical balls. All round athletic balls can be tested. A vertical board 100 inches high is painted white with black graduations at 2 inch intervals. Two quick-release supports are located so that the bottoms of the balls resting on the supports are exactly 100 and 72 inches respectively above the rebound plate. Quick-release supports are used to prevent ball spin, in order that the rebound on a particular point on the ball may be determined and to insure vertical rebound. The base support consists of a steel plate 18 x 18 x 4 inches placed firmly on the floor. A spot lamp throwing a narrow intense beam is used to cast the shadow of the rebounding ball on the scale.

a. Calibration. The spot lamp is placed 20 feet from the board and adjusted so that the shadow cast on the board will give a true reading.

b. Procedure. The ball is set on the proper support. After release the maximum height of the shadow cast on the board is recorded. All round inflatable items are dropped from the 72 inch support, and the top of the cast shadow is read. The average of 3 drops is reported as the rebound. All other balls are dropped from the 100 inch support and the bottom of the cast shadow read. These balls are dropped three times, once on each of the three axes. The average of the 3 drops is reported as the rebound. Rebound may be read without the aid of a light or shadow. In this case, the observer must stand at some distance from the board with his eye at approximately the height of the expected rebound. This test is best performed by a team of 2 operators, one releasing the support, retrieving and repositioning the ball, while the other observes and records the rebound. The temperature coefficient of rebound is high for some items, especially rubber balls. The specimens must be allowed to condition completely before the test is performed.

2. Footballs and striking bags. These are tested with a Tinius Olson Impact Tester, model #33500 adapted for footballs.

Fatigue Characteristics

1. Inflatable items. All inflated items can be tested.

a. Introduction. Most of the tests on inflatable items, such as size, weight, rebound and out-of-roundness determine the acceptability of the product for play. Fatigue tests, however, measure the durability. Two kinds of fatigue tests are in use: dynamic fatigue (rolls machine, see Figure 74), and static fatigue (shaper). Spherical items can be tested on both machines; others, such as footballs and striking bags, can be tested only in the shaper.

The primary disadvantage of the shaper is that it produces no appreciable wear, whereas the rolls machine results in wear, corresponding to wear in service, so far as available comparison permits judgment on this point. For research, the dynamic tester is preferred

whenever feasible. For control tests, the shaper test is preferred because it is quicker and less expensive.

The question of correlation of the two test methods is important. One evidence of correlation is that both types of test produce the same types of failure. In this respect, no single instance of disagreement was found in Army Quartermaster tests. Correlation between laboratory methods and actual service tests has been attempted and has been established for nature of failure and ranking of balls in many cases. In every instance examined, the type of failure encountered in the laboratory has paralleled those developed in play. The ranking of leather-covered molded basketballs and leather and coated-fabric footballs by laboratory and playing tests shows good correlations.

b. Dynamic fatigue.

(1) Purpose. The dynamic fatigue test determines the relative durability of spherical inflatable items.

(2) Items. Soccer balls, volley balls, water polo balls and basketballs are tested.

(3) Apparatus. Elmes testing machine K-3721 (see Figure 74), was used for these tests.

(4) Procedure. The distance between the wheels of the roller tester must be set at the desired distance for each type of ball. The distances are as follows: basketballs 8½ inches, volley balls 7½ inches, soccer balls 7 13/16 inches, water polo balls 7 13/16 inches.

After the machine has been set it is started. The test ball is tossed into the hopper and the machine run for 30 minutes. During this time it is necessary to observe the machine frequently to make certain that the ball has not bounced out. After 30 minutes remove the ball, record the out-of-roundness, make notes on any change of condition and reinflate to the original air pressure. Continue this procedure until the ball fails. Two but not more than two balls may be tested simultaneously without changing the number of passes per unit time. The distance between the rollers must be carefully measured. A pair of inside calipers and a vernier caliper are convenient for this purpose. The distance between the rolls must be corrected for backlash, if any. The backlash is determined by measuring the increase in distance between the axes when the ball is between the rolls.

Carry

Purpose: To determine the carry (distance) of flight of a ball struck with a standard blow.

Apparatus. Driving machine (see Figure 75).

Procedure. The driving range is marked at 5 yard intervals to make measurement easier. The driving apparatus is fitted with the appropriate arm and tee. The machine is cranked until the striking

arm locks into place. After the specimen is positioned on the tee, the trigger is released. The flight or carry is measured.

1. Golf balls. The trajectory of flight is important for this item. The position of the tee is adjusted until the standard ball has the desired trajectory. This trajectory is such that the angle of maximum height is approximately 6 degrees. Golf balls are struck once on the pole axis.

2. Other items. Baseballs and softballs are struck on three principal axes, the axis passing through the waist of the figure 8 panels being struck last. All specimens should be marked with identifying numbers. India ink slightly diluted with alcohol is a good agent.

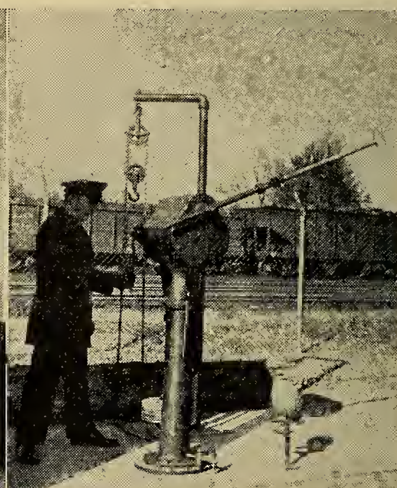

Figure 74. (left) A rebounding machine for all spherical inflated balls. Balls when thrown from between the rollers, strike the back board and rebound into wooden hopper at top. Balls are tested at intervals for bulging seams, tears, cover peeling and bounce. (*Courtesy of United States Quartermaster Corps, Jeffersonville Quartermaster Depot. Plate number 1020–5.*)

Figure 75. (right) An impact tester for footballs. Small end of striking mallet on the swinging arm resembles the toe of a football shoe. The impact force can be regulated to "kick" the football for any distance desired. After many tests, each ball is checked for broken seams and out-of-roundness. Balls are graded accordingly. The same machine, with a different mallet, can be used when testing golf balls for distance or drives. (*Courtesy of United States Quartermaster Corps, Jeffersonville Quartermaster Depot. Plate number 1020–7.*)

Balance of Golf Balls

Purpose: To measure the degree of balance in terms of seconds of turnover time. The likelihood of a golf ball hooking or slicing through no fault of the player depends upon the degree of balance of the ball. This test is a convenient method of measuring this degree.

Apparatus. Any dish or casserole of 1500 ML capacity; a stop watch; a solution of magnesium sulfate of specific gravity of 1.228, containing a small amount of wetting agent, such as Gardinol W. A.

Procedure. The ball is floated in the solution and the top point of that section remaining above water is dotted with a wax pencil. The ball is turned exactly upside down. Reverse the ball so that the drip runs off the dot. The specimen is lowered into the solution to approximately its floating depth and released with little or no tendency to bob up and down. The time required for the ball to return to its original position is reported in .1 seconds as the turnover time. The rapidity of reversal is proportional to the balance. Two seconds should be the minimum time for return.

Two operators are needed, one to manipulate the ball and one to determine the turnover time. Some experience may be needed before the operator can release the ball properly. The salt solution is slightly corrosive to the skin, making it desirable that the operator wear thin rubber gloves especially if many tests are being made. The salt solution should be washed off the hands after the test.

Cutting Resistance of Golf Balls

Apparatus. Guillotine (see Figure 76). The weight of the falling parts shall be 7.15 pounds. The height of the drop measured from the top of the cup to the edge of the knife shall be 41 inches.

Procedure. The ball is positioned in the cup with one of the poles on top and the weight raised against the stop. The knife is released. The ball is turned over, care being taken that the ball does not rest on the previous cut, and the procedure repeated. For inspection testing, the ball is examined to determine whether the cover has been cut through. For comparative testing, the specimens are ranked in order of their resistance to cutting.

Make certain that the ball does not rotate in the cup when struck and that the carriage falls freely. The weight should be secured by means of a wooden wedge or clamp to prevent movement on impact. The amount of offset of the cup which is important as it determines the amount of sheer, should be checked from time to time.

The Flattening of Baseballs and Softballs

Purpose: To determine resistance to deformation. One of the most common failures of baseballs and softballs is the tendency to go out of shape with use. The dynamic fatigue test provides information as to resistance to such deformation, but it is time consuming. The present test is faster and equally reliable.

Apparatus. Flattening apparatus (see Figure 77), Ames Dial Gauge, Model #282.

Calibration. The apparatus is set so that the dropping distance is two feet when softballs are tested and three feet for baseballs. The distance is measured from the bottom of the weight when raised, to the top of the ball when in position.

Procedure. The specimen is marked with a dot at the center of a figure 8 panel. The ball is placed in the depression of the dial gauge support and after the presser foot is adjusted to rest on the marked spot, the gauge reading is recorded. The ball then is placed in the depression of the flattening apparatus with the marked spot directly on top. The catch is set for a free fall and the weight raised against the stop, tipping the release. After being struck, the ball is repositioned so that the dot is again on top. The procedure is repeated until the weight has been dropped on the ball a total of three times. The ball is repositioned on the gauge support so that the presser foot is exactly on the same spot where it was struck and the reading recorded. This latter reading is subtracted from the original reading and the result reported as the flattening.

Impact Resistance of Badminton and Tennis Rackets

Purpose: To evaluate impact resistance. Two tests are employed to evaluate rackets, the stringing and the frame being tested separately.

Apparatus. Air gun fitted with a one inch diameter barrel; a projectile ball having approximately the following characteristics (the center of a golf ball may be used):

Diameter, 1 inch
Weight, 3 ounces
Rebound after 100 inch drop, 44 inches

Procedure. The center of percussion of the racket is found by holding the racket by the handle and striking the strings smartly with the fingers. The center of percussion is that spot at which no vibration is felt. This is called the "sweet spot" by players.

To test the stringing the racket is suspended by means of the rubber hose approximately 6 inches from the muzzle of the air gun, then struck at the following points, successively: center of percussion; one inch from the top, bottom, right and left sides of the frame. The cycle is repeated until the specimen fails. The number of blows and point of failure are reported.

To test the frame, the racket is suspended as described in the previous test and struck successively at the following points: top, bottom, right and left sides of the frame. The cycle is repeated until failure occurs. The latter test is preferable because a badminton racket seldom fails from striking a shuttlecock with the strings, but rather from striking the frame sharply against a solid object, as the ground.

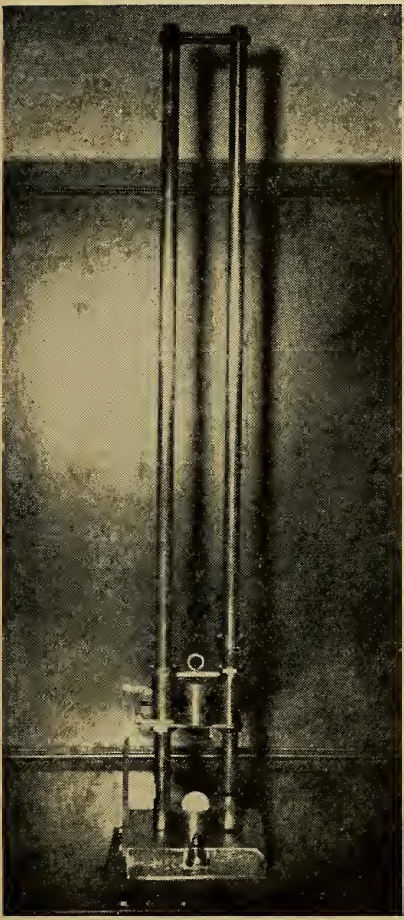
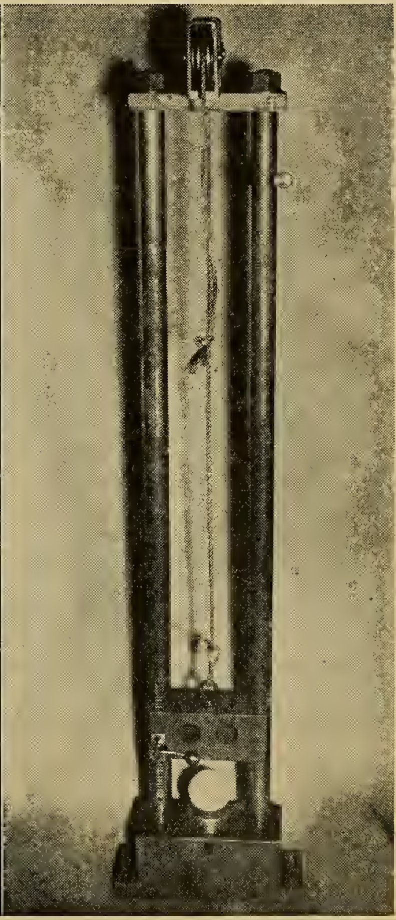

Figure 76. (left) A machine for testing the covers of golf balls. The dropping weight may be increased until the cutting edge, just below the weights, penetrates the balatta cover. Covers are graded according to degree of break or cut. (*Courtesy of United States Quartermaster Corps, Jeffersonville Quartermaster Depot. Plate number 877–1.*)

Figure 77. (right) A device for testing a baseball or softball for resistance to an impact. The weight, when dropped from various heights, resembles the hitting action of a bat against the ball. The ball is then measured for roundness. The balls are graded according to the degree of out-of-roundness or flat spots. (*Courtesy of United States Quartermaster Corps, Jeffersonville Quartermaster Depot. Plate number 877–2.*)

APPENDIX B

Functional Sportswear

A CHECK-LIST QUESTIONNAIRE

Listed below are items important to intelligent selection of sportswear. They are grouped into eleven categories, and under each heading specific questions are raised which will guide a purchaser's thinking. Occasional reference to this list before making a purchase may prove both helpful and profitable.

NATURE OF THE ACTIVITY

What are the specific requirements of the activity for which the costume is to be worn?

LOCAL CONDITIONS

A. *Purpose*

For what activities is the costume to be worn?
General or specific use?

B. *Location*

1. In what climate and under what weather conditions will the costume be used?
2. Is it to be worn indoors, out-of-doors, or in both places?

C. *Age*

In what age group is the person or persons for whom the costume is intended?

D. *Frequency of use*

How often will the garments be used?

E. *Time for change of costume*

Is time allotment for change of costume a factor?

F. *Facilities for care and repair*

1. What facilities are there for care and repair of costume?
2. Is the costume suitable for these conditions in terms of time, expense and other similar factors?

APPEARANCE

A. *Style*

1. In what styles is the costume available?
2. Is the style suited to the age and body build of the wearer?
3. Is the costume in style with current, sound fashion?
4. What styling features contribute to good fit?

B. *Color and pattern*

1. In what colors and color values is the costume available?
2. Are color and pattern of the costume suited to the build, coloring, personality and age of the wearer?
3. Are color and pattern in harmony with the activity and its surroundings and traditions?

C. *Size*

Is the size adequate for good fit in terms of neat, attractive appearance?

D. *Retention of shape*

1. Will the costume retain its shape during use to the degree that an attractive appearance is reasonably maintained?
2. Has a finish been applied for this?

E. *Crease resistance*

1. Is the costume crease resistant?
2. Has a crease resistant finish been applied?

F. *Non-transparency*

1. Is the fabric transparent?
2. If so, can adequate provision be made for the insurance of an attractive appearance, in good taste?

G. *Texture* (and hand)

Are the texture and hand such that the costume has body and drapes (or fits) well?

Comfort

A. *Construction for action*

1. Is the garment constructed so as to permit freedom of action and ease of movement?
2. Is it full-cut?

B. *Size*

Is the size adequate for free, unhampered movement?

C. *Weight*

1. Does the weight of the garment cause discomfort and interfere with action?
2. Is the weight adequate for good hand?

D. *Warmth and coolness*

Is the costume too warm or too cold for the particular activity for which it is worn?

E. *Texture*

Does the texture contribute to comfort or is it too rough and scratchy?

Wearing Qualities of Fabric

1. Special physical characteristics
   a. What is the tensile strength, wet, dry?
   b. Does the fabric have good elongation and recovery?
   c. How well does the fabric wear when subjected to abrasive action?
   d. What is the weight of the fabric?
   e. Is there any slippage of threads?
   f. From what fiber(s) is the fabric constructed? What is the quality of the fiber?
   g. What fabric is used? Is it woven or knit? What is the thread count?

2. Fabric properties
   a. How does the fabric react to perspiration, dirt, moisture (rate and amount of absorption), water (absorption-evaporation, hot water, shrinkage, spotting, sea water), mildew (mold, fungi), dry cleaning, laundering (and ironing), light (sunlight, fluorescent), chlorine, moths?
   b. Have finishes been applied for any of the above properties?

3. Color
   a. What type dye was used to color the fabric?

   b. What finishes have been applied for color fastness?
   c. What is the color fastness of the fabric to perspiration, dirt, dry cleaning, light (sunlight, fluorescent), laundering (and ironing), atmospheric fading, sea water, chlorine, crocking?

4. Thread
   a. From what type fiber is the thread manufactured?
   b. What is the size and strength of the thread?
   c. What are the wearing qualities of the thread?
   d. What colorfast properties does the thread possess?

5. Garment construction
   a. What type stitching is used? How many stitches to the inch?
   b. What type, size hems, seams and similar items, are used?
   c. What fasteners are used? Buttons? Slide fasteners? Elastic? Gripper fasteners?

SUITABILITY

A. Does the suit conform to sports etiquette in dress?
B. Does the suit conform to standards of propriety (general and local)?

SAFETY

Are there any features of the garment that make it unsafe, or features that if added would increase its safety?

CARE

What care does the garment require—regular, cleaning, storage?

REPAIR

Are any special methods of repair advised?

COST

A. What is the initial cost?
B. What is the cost of upkeep?

GUARANTEE AND TESTING

A. Has the garment been tested by any recognized testing agency?
B. Is it guaranteed for any specific length of time and amount of wear?

APPENDIX C

Styling for Action and Fit

Suggestions for Purchasing

Examine garments for the following details that contribute to action:

Dresses

Freedom of action across the shoulders. Styling may include

1. Full cut
2. Pleats—either a center pleat in the back of the waist, or pleats placed at the shoulder and extending from shoulder to waistline. These can be used in both front and back of the waist, but are usually placed at the back, near the armhole. Pleats may be exposed or concealed
3. Yoke in front and/or back of waist
4. Shirring in front and/or back of waist
5. Raglan style sleeves

Freedom of action in elevation of the arms above shoulder level. Styling features vary for long and short sleeves.

1. Long sleeves may have
   a. a high-cut armhole that does not bind at any point in the action
   b. inserts (usually rib-knit gussets) set in at underarm woven inserts may be pleated to allow for stretch
   c. raglan style sleeves

2. Short sleeves may be
   a. cap sleeves
   b. extra wide sleeves (without additional styling features)
   c. button sleeves—these sleeves are buttoned on the top side of the sleeve and may be opened when a greater range of movement is desired
   d. slit sleeves—the slit usually extends from shoulder to sleeve cuff
   e. pleated sleeves—one or two pleats give greater circumference to sleeve

Freedom of leg action. Styling features may include

1. Pleats front or back for fullness
2. Free-swing, gored skirt
3. Circular cut skirt

Shirts and Jackets

The same action features important to dress waists are needed in shirts with the exception of the underarm gussets. Since the shirt is not attached to the skirt, there is greater flexibility in underarm action, particularly if the armhole is cut high, full, and fits well at armpit. Men's shirts are usually styled with a cut-out on each side of the bottom band, for better fit across the hips, and to help in keeping the shirt tail tucked in. An underarm gusset is, therefore, helpful but not essential. Jackets should be roomy enough to fit comfortably over sweaters, blouses or shirts.

Skirts

The same features important to dress skirts are equally applicable to separate skirts. In addition, a nonslip type of waistband is needed as an anchor for the shirt that is worn underneath the skirt.

Pants

Styling may include

1. Full cut
2. Pleats
3. Elastic inserts (frequently used in ski pants, riding breeches and basketball pants)
4. Cut-out on bottom of pants legs (shorts)

Examine garments for the following details that contribute to good fit:

General features. Styling may include

1. Full cut

2. Tapered sleeves, tapered pants legs
3. Darts, tucks, shirring

Waistbands. Styling may include

1. Slide fastener inserted in band to permit adjustment
2. Ties or other adjustable fasteners on band
3. Nonslip tape inside the band
4. Elastic inserts on band

APPENDIX D

Good Garment Construction

Suggestions for Purchasing

Examine the garment for the following details of construction:

Body of Garment

1. Full cut includes easy fit at chest or bustline, and across shoulders and hips; and adequate length at underarm seam from pit of arm to waistline, to permit elevation of arms with a minimum displacement of waistline.

2. Collars should have an easy fit at neckline for comfort and reduction in strain and wear; good fit at pit of neck for normal neckline; smooth, even stitching from edge of collar; and smooth interfacing.

Low band collars are especially suited to the man who has a short neck. Convertible collars that can be worn open or closed may serve for either business or sports and make possible adjustment for warmth and coolness. The turtle neck style contributes to warmth and is a good styling feature for the individual who has a long neck. Shawl and gaucho collars add softness to the neckline; closed collarless necklines (round or V) should be ample in neck opening and well reinforced to resist strain.

3. Hems should be wide enough to allow for adjustment if necessary, approximately 3 inches in width (circular skirts excepted), and finished with seam binding or felled by hand. The upper part of hemline edge should be stitched for lightweight fabrics and cross-stitched or seam binding for heavyweight fabrics.

4. Seams should be wide enough to allow for adjustment if necessary, approximately one inch or more; finished with edge stitching, overcast, or double sewn and felled for lightweight fabrics; overcast or pinked for heavyweight fabrics; double-stitched in all sections of garment where there may be considerable stretch; binding and edge stitching for all fabrics that tend to ravel.

5. Pleats should have sufficient fullness to retain shape (Nylon and some rayon fabrics can be thermoset, a process that makes pleats permanent even through laundering.); reinforcement at top of pleat; and placement on skirts high enough to serve purpose (fullness).

6. One-piece dress should not be snug at the waistline, unless fabric is a knit or elastic construction; should be taped to prevent stretching; and should be sewn with at least two rows of stitching.
Skirt and pants should be wide enough at waistband to prevent binding (at least one inch wide), stayed with some firm fabric at waistband to prevent stretching, and easy in fit.

7. Plackets should have sufficient length to permit the wearer to get into or out of garment with ease (skirt placket at least 7 inches long, underarm placket at least 9 inches long, sleeve plackets at least 4½ inches long); openings reinforced at each end; tuck seam of concealed slide fastener plackets wide enough to cover fastener; and loops of placket large enough to allow for buttoning with ease.

8. In general, sleeves should have ample room across sleeve cap, easy fit across the biceps, and armholes overcast or bound.

Long sleeves, in addition to the above features, should have enough fullness at elbow to avoid strain when bending arm, underseam long enough to prevent pulling, and placket wide enough to prevent gapping. Long sleeves are preferable in cold weather and for protection against wind and sun, but may prove a distraction on windy days if they are cut very full. Short sleeves are cool and unhampering in action.

9. Pockets may serve several purposes: (1) ornamentation, (2) repository for various objects, and (3) warmth. Some pockets are designed for all three purposes. This is true, especially, in golf jackets. One pocket may have two separate openings, one cut on the slant and one horizontal. A slide fastener closing prevents contents of pocket from falling out during periods of vigorous activity.

Pockets should be placed so as not to interfere with action, reinforced at ends of slash to prevent tearing, ample in size for intended purpose, reinforced to prevent stretching if cut on the bias, lined with a durable fabric to prevent holes—double fabric construction on the bottom of the pocket is excellent for this purpose, and rounded at bottom to prevent lodging of dirt—not absolutely essential to a well-constructed pocket.

Details

All details should meet the same property requirements as the body of the garment such as color fastness and launderability. Exceptions to this rule follow: (1) features that are easily removable do not require properties necessary for laundering, ironing, or cleaning; (2) items that are not exposed to light, as for example, shoulder pads, need not be colorfast to light.

Fastenings vary in construction with each type of fastener.

1. Buttons should be large enough to fit buttonholes with ease, diameter of button should be 1/8 inch less than buttonhole; rustless, if metal molds are used for covered buttons; resistant to breakage, and launderable, unless buttons are easily removed (Studs are excellent for sport clothes since they can be removed for laundering or cleaning purposes); well anchored to the garment (An extra layer of cloth under the button adds strength.).
2. Buttonholes should be reinforced at each end, placed horizontally or diagonally on the garment (Vertical buttonholes may open when garment is stretched during movement unless garment fits easy.), bound or worked on the straight grain of the fabric to preserve shape, finished neatly on the back, 1/8 inch larger than the diameter of the button, and stayed with extra thread or extra stitching before cut to prevent stretching (worked buttonholes, only).
3. Loops should be long and wide enough to permit garment to be buttoned with ease and firm enough to allow for easy handling.
4. Slide fasteners should be rustproof; concealed unless used as part of trimming or design of garment; sufficiently long to permit wearer to get into or out of garment with ease; used only on fabric that is shrinkproof, otherwise fastener will buckle after washing; suited in weight to that of the garment fabric (A lightweight fastener should not be used on a heavy fabric and vice versa.); and designed so as to unlock in case fabric becomes caught in the track. (This type of fastener is exceptionally serviceable for sportswear. It opens and closes quickly, and is not a problem in laundering and ironing. Replacement cost may be higher than for some buttons but fasteners can be repaired and newer style fasteners have much greater durability.)
5. Hooks and eyes are rarely used except to reinforce the belt line on a skirt. Size is determined by weight of the fabric and the purpose for which the garment is used.
6. Snaps should be rustproof, firm and secure, and sufficiently strong to withstand strain. Old style snaps are no longer used as fasteners. However, a gripper button that is similar in construction but much sturdier than a snap is used on some garments, epcecially gymnasium suits. It presents no problem in laundering.
7. Metal eyelets and ties should be rustproof; placed only on

fabrics that are tightly woven or reinforced, otherwise they will pull out of the fabric; and secured to the garment to prevent loss (ties).

8. Belts should have buckles that are rustproof, several eyelets to allow for adjustment, prongs of buckle long enough to prevent slipping and opening, and a 3 to 4 inch extension beyond the buckle.

Shoulder pads should be firmly padded, easily removable (Pads that snap in and out are excellent since they can be removed easily when the garment is laundered and then snapped back into place.), suitable in size and shape for the garment on which they are used, and covered.

Linings should be hemmed by hand for better fit (This is a highly desirable but not an essential feature of the better suits.); comparable in quality to the garment they line; water repellent if used in a water-repellent garment, otherwise the lining draws in the moisture from the outside; labeled as to fiber content; firmly joined to the garment; full enough to prevent binding, without being bulky; particularly durable if used as reinforcement at elbows; and finished separately at the hem or tacked to the garment with French tacks, or finished with a puff at the bottom of the jacket.

Facing should be smooth and well anchored, wide enough to prevent slipping or showing of seams, and firm enough to give body to garment.

Stitching should be small—at least 14 stitches to the inch (except for stitching that is used as a trim); firm and the same on the right and wrong side of garment; and made with thread that is suited to the fabric on which it is used.

Bibliography

Preface

Feeley, Stephen. "First Census of Manufacturers Report Since 1939," *The Sporting Goods Dealer,* 71:69, June, 1949.

Chapter I. Archery

Elmer, Robert P. *Target Archery.* New York: Alfred A. Knopf, Inc., 1946.

"Official Rules for Target Tournaments." *Official Individual Sports Guide.* National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950–52.

Chapter II. Baseball and Softball

Hughes, W. L., ed. *The Book of Major Sports.* New York: A. S. Barnes and Company, Inc., 1938.

Official Rules for Baseball. National Baseball Congress of America. Wichita, Kansas: 1950.

The Baseball Almanac. New York: A. S. Barnes and Company, Inc., 1949.

United States Office of Quartermaster General. *Baseballs.* Joint Army-Navy Specification, JAN-B-522, November 28, 1947. (Mimeographed)

——. *Baseballs.* Quartermaster Corps Standard Inspection List Number 488, August 1, 1946. (Mimeographed)

——. *Bases, Baseball.* Quartermaster Corps Tentative Specification, K.C.Q.M.D. Number 15, December 21, 1943. (Mimeographed)

——. *Bats, Baseball.* Quartermaster Corps Tentative Specification, J.Q.D. 639A, June 23, 1945. (Mimeographed)

——. *Gloves, Baseball, Fielder's.* Quartermaster Corps Tentative Specification, K.C.Q.M.D. Number 26B, November 27, 1944. (Mimeographed)

——. *Guard, Baseball, Leg.* Quartermaster Corps Tentative Specification, J.Q.D. Number 624, February 19, 1945. (Mimeographed)

Official Softball-Track and Field Guide. National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950.

United States Office of Quartermaster General. *Ball, Softball, (Leather-covered).* Quartermaster Corps Tentative Specification, J.Q.D. Number 681, June 28, 1945. (Mimeographed)

Chapter III. Basketball

"Compilation of Data Pertaining to Types of Failure in Sewn Basketballs." Report Number 319, Engineering Division, Jeffersonville Quartermaster Depot, Jeffersonville, Indiana: August 9, 1946.

Handbook. Chicago: National Federation of State High School Athletic Associations, 1948–49.

United States Office of Quartermaster General. *Basketball, Molded.* Quartermaster Standard Inspection List Number 422, June 5, 1945. (Mimeographed)

——. *Shoes, Athletic.* Quartermaster Corps Tentative Specification, B.Q.D. 272H, November 22, 1946. (Mimeographed)

Chapter IV. Bowling

Mitchell, E. D., ed. *Sports for Recreation.* New York: A. S. Barnes and Company, Inc. 1936.

Chapter V. Boxing and Wrestling

Official NCAA Boxing Guide. National Collegiate Athletic Bureau: Box 757, Grand Central Station, New York 17, New York, 1950.

Tanners' Council of America, Inc. *Dictionary of Leather Terminology.* Fourth Edition, 1946.

United States Office of Quartermaster General. *Bag, Striking.* Quartermaster Corps Tentative Specification, J.Q.D. Number 626, December 20, 1944. (Mimeographed)

——. *Bags, Training, Boxing.* Quartermaster Corps Standard Inspection List Number 417, June 1, 1945. (Mimeographed)

——. *Gloves, Boxing.* Quartermaster Corps Tentative Specification, J.Q.D. Number 622, February 24, 1945. (Mimeographed)

Official NCAA Wrestling Guide. National Collegiate Athletic Bureau: Box 757, Grand Central Station, New York 17, New York, 1950.

United States Office of Quartermaster General. *Mat, Wrestling.* Quartermaster Corps Tentative Specification, K.C.Q.M.D. Number 102, September 1, 1944. (Mimeographed)

Chapter VI. Fencing

Amateur Fencers League of America. *Fencing Rules.* New York: Privately Printed, 1940.

Vince, Joseph. *Fencing.* New York: A. S. Barnes and Company, Inc., 1940.

Yost, Mary. "The Selection and Care of Fencing Equipment," *Official Individual Sports Guide.* National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950–52.

Chapter VII. Field Hockey

Elliott, Frances. "Some Fundamentals of Goalkeeping," *Official Field Hockey–Lacrosse Guide.* New York: A. S. Barnes and Company, Inc., 1941.

Official Field Hockey–Lacrosse Guide. National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950–52.

Chapter VIII. Football

Mock, Harry, M.D., and others. "Head On," *Safety Education,* 28:10, January, 1948.

——. "Head On," *Safety Education,* 28:31, February, 1948.

Office of Naval Operations. *Intramural Programs.* Annapolis, Maryland: United States Naval Institute, 1950.

Official Football Rules. National Collegiate Athletic Bureau: Box 757, Grand Central Station, New York 17, New York, 1950.

United States Office of Quartermaster General. *Football.* Quartermaster Corps Standard Inspection Procedure, Number 311, August 23, 1946. (Mimeographed)

——. *Football, Rubber-Covered.* Quartermaster Corps Tentative Specification, J.Q.D. Number 752, February 14, 1946. (Mimeographed)

——. *Pads, Hip.* Quartermaster Corps Standard Inspection List Number 420, June 1, 1945. (Mimeographed)

——. *Pads, Shoulder, Football.* Quartermaster Corps Standard Inspection List Number 413, May 25, 1945. (Mimeographed)

——. *Uniform, Football.* Quartermaster Corps Tentative Specification, P.Q.D. Number 535, October 2, 1945. (Mimeographed)

Chapter IX. Golf

Hutchison, H. G. *Fifty Years of Golf.* London: Country Life Press, 1920.

Nelson, Byron. *Winning Golf.* New York: A. S. Barnes and Company, Inc., 1946.

Searles, W. R. "This Month in Golf," *Sports Age,* 32:33, July, 1939.

United States Office of Quartermaster General. *Ball, Golf.* Quartermaster Corps Tentative Specification, Number 752, September 28, 1945. (Mimeographed)

Waring, Ralph G. "Refinishing Golf Clubs," *Industrial Arts and Vocational Education,* 26:218, May, 1938.

Yocom, R. B. and Hunsaker, H. B. *Individual Sports for Men and Women.* New York: A. S. Barnes and Company, Inc., 1947.

Chapter X. Lacrosse

Menke, Frank G. *The New Encyclopedia of Sports.* New York: A. S. Barnes and Company, Inc., 1947.

Official Field Hockey–Lacrosse Guide. National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950–52.

Official Lacrosse Guide. National Collegiate Athletic Bureau: Box 757, Grand Central Station, New York 17, New York, 1950.

Chapter XI. Ice Hockey

Jeremiah, Eddie. *Ice Hockey.* New York: A. S. Barnes and Company, Inc., 1942.

Menke, Frank G. *The New Encyclopedia of Sports.* New York: A. S. Barnes and Company, Inc., 1947.

Chapter XII. Racket Games
(Tennis, Badminton, Squash)

Menke, Frank G. *The New Encyclopedia of Sports.* New York: A. S. Barnes and Company, Inc., 1947.

"Science Checks Up on Racket Tension," *Sports Age,* May, 1940. (Pamphlet)

The Official Tennis Guide and Yearbook of the United States Lawn Tennis Association. New York: United States Lawn Tennis Association, 1950.

Tynan, J. N. "Manufacturing Laminated Tennis Rackets," *Mechanical Engineering,* 69:735–8, September, 1947.

United States Office of Quartermaster General. *Balls, Tennis.* Quartermaster Corps Tentative Specification, J.Q.D. Number 628, Amended May 3, 1945. (Mimeographed)

——. *Balls, Tennis.* Quartermaster Corps Inspection Service, Standard Inspection List Number 531, July 12, 1946. (Mimeographed)

——. *Nets, Tennis.* Quartermaster Corps Tentative Specification, J.Q.D. Number 757, Amended February 13, 1947. (Mimeographed)

——. *Racket, Tennis, With Press.* Quartermaster Corps Tentative Specification, J.Q.D. Number 757, Amended February 13, 1947. (Mimeographed)

——. *String, Nylon, Tennis and Badminton.* Quartermaster Corps Tentative Specification, J.Q.D. Number 699, July 10, 1945.

Official Tennis–Badminton Guide. National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950–52.

United States Office of Quartermaster General. *Nets, Badminton.* Quartermaster Corps, Standard Inspection Procedure 333, January, 1947. (Mimeographed)

——. *Rackets, Badminton, With Press.* Quartermaster Corps Tentative Specification, J.Q.D. Number 759, September 12, 1946. (Mimeographed)

The Official Guide of the United States Squash Racquets Association. United States Squash Racquets Association, 1948.

United States Office of Quartermaster General. *Balls, Squash (Racquets).* Quartermaster Corps Tentative Specification, J.Q.D. Number 616, February 1, 1945. (Mimeographed)

Chapter XIII. Skiing

Searles, W. R. "Winter Goods," *Sports Age,* 2:24–26, September, 1939.

——. "Skis, Poles and Bindings," *Sports Age,* 3:16–17, August, 1940.

Schumway, Carl. "Ski Merchandising," *Sports Age,* 1:22–23, November, 1938.

United States Office of Quartermaster General. *Skis.* Quartermaster Corps Tentative Specification, B.Q.D. Number 119A, June 14, 1945. (Mimeographed)

——. *Skis.* Quartermaster Corps Standard Inspection Procedure, Number 385, June, 1948. (Mimeographed)

——. *Kit, Repair, Ski.* Quartermaster Corps Tentative Specification, B.Q.D. Number 45F, January, 1945. (Mimeographed)

——. *Poles, Ski.* Quartermaster Corps Tentative Specification, B.Q.D. Number 107, March 31, 1945. (Mimeographed)

Chapter XIV. Soccer, Volley Ball, Handball

"Compilation of Data Pertaining to Types of Failures in Sewn Basketballs." Jeffersonville, Indiana: Engineering Division, Jeffersonville Quartermaster Depot, Report Number 319, August 9, 1946.

Official Soccer Guide. National Collegiate Athletic Bureau: Box 757, Grand Central Station, New York 17, New York, 1950.

Official Soccer–Speedball Guide. National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950–52.

United States Office of Quartermaster General. *Balls, Soccer.* Quartermaster Corps Tentative Specification, K.C.Q.M.D. Number 58B, October 30, 1944. (Mimeographed)

——. *Ball, Soccer, Rubber-Covered.* Quartermaster Corps Tentative Specification, J.Q.D. Number 641A, February 10, 1947. (Mimeographed)

Official Volley Ball Guide. United States Volley Ball Association: Box 109, Berne, Indiana, 1950.

Recreational Games and Volley Ball Guide. National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1949–51.

United States Office of Quartermaster General. *Ball, Volley.* Quartermaster Corps Tentative Specification, K.C.Q.M.D. Number 11B, October 30, 1944. (Mimeographed)

——. *Ball, Volley, Rubber-Covered.* Quartermaster Corps Tentative Specification, J.Q.D. Number 642A, February 10, 1947. (Mimeographed)

——. *Nets, Volley Ball.* Quartermaster Corps Tentative Specification, J.Q.D. Number 615, December 9, 1944. (Mimeographed)

United States Office of Quartermaster General. *Handballs.* Joint Army-Navy Specification, November 28, 1947.

Chapter XV. Track and Field

Bresnahan, G. T. and Tuttle, W. W. *Track and Field Athletics.* St. Louis: C. V. Mosby Company, 1947.

Ganslen, R. V. "The Pole Makes the Vaulter," *Scholastic Coach,* 7:18, March, 1948.

Official Rules. Chicago: National Federation of State High School Athletic Associations, 1950.

Official Softball—Track and Field Guide. National Section on Women's Athletics: 1201–16th Street, N.W., Washington, D.C., 1950.

Chapter XVI. General Care and Repair

Office of Naval Operations. *Intramural Programs,* Annapolis, Maryland: United States Naval Institute, 1950.

The Care of Leather. Washington, D.C.: United States Department of Agriculture, Farmers' Bulletin Number 1183. n.d.

Chapter XVII. Clothing As Equipment

Burris-Meyer, Elizabeth. *This Is Fashion.* New York: Harper and Brothers, 1943.

United States Office of Quartermaster General. *Shorts, Athletic.* Quartermaster Corps Tentative Specification, P.Q.D. Number 529, Amended October 26, 1945. (Mimeographed)

Chapter XVIII. Materials

American Leathers. New York: American Leather Producers, Inc., 1929.

United States Department of Agriculture. *Comparative Strength Properties of Woods.* Washington, D.C.: Technical Bulletin Number 158. n.d.

Encyclopedia Britannica. *Rubber: Production and Manufacture,* 19:607.

Meyers, Mel. "Sporting Goods Show That Plastics Can Take It," *Plastics,* 7:22–25, June, 1948.

Matthews' Textile Fibers. Ed. Herbert R. Mauersberger. 5th ed. New York: John Wiley and Sons, Inc., 1947.

Physical-Chemical Properties and Processing of Nylon Textiles. Wilmington: E. I. du Pont de Nemours and Company, Inc., Nylon Division. Bulletin. n.d.

Rules and Regulations Under the Wool Products Labeling Act of 1939. Washington, D.C.: Federal Trade Commission. Effective July 15, 1941.

Sherman, Joseph V. and Sherman, Signe Lidfeldt. *The New Fibers.* New York: D. Van Nostrand Company, Inc., 1946.

Index

Amateur Athletic Union, 253, 316
Amateur Fencers League of America, 94
Amateur Softball Association, 53, 54
  Joint Rules Committee of, 56
American Badminton Association, 211
American Bowling Congress, 69, 72
Archery, 1–27
  costume for, 23–24
  equipment tackle for, 2
  history of, 1–2
    (*See also* Arrow; Bow)
Armguard, for archery, 21–22
    care and repair of, 27
  lacrosse, 183
Arrow, 2–9
  care and repair of, 24–26
  diameter of, 5
  length of, 5
  metal, 4
  parts of, 3
  plastic, 4
  properties of, 4–9
  qualities of, 3
  types of, 3–4
    footed, 3
    self, 3
  weight of, 5
  wood for, 3–4
Arrow tassel, 23
Badminton, 204, 208–215
  wool practice balls for, 213
Badminton racket, 209–211
  frame of, 209–211
  impact resistance of, 332–333
  measurements for, 211
  stringing of, 211
Ball carrier, 71–72
  care and repair of, 75
Balls, leather, cleaning of, 268
    inflation of, 268
    repair of, 268–269
    storage of, 268
  rubber-covered, cleaning of, 269
    repair of, 270
    storage of, 270
      (*See also* specific sport)
Baseball, 28–52
  early forms of, 28
Baseball bats (*see* Bats)
Baseball equipment, 29
  care and repair of, 56–59
Baseball gloves (*see* Gloves, baseball)
Baseballs, care and repair of, 57–58
  centers of, 30
  cover thickness of, 29
  flattening of, 331–332
  inspection of, general considerations
    for, 31

Baseballs (*Continued*)
  leather for, 29
  yarn winding for, 30–31
Bases, 31–32
Basketball, 60–67
  early form of, 60
Basketballs, molded, 61–63
  rubber-covered, 61, 64–65
  stitched, 61, 63
Bats, 32–38
  care and repair of, 58
  Grade One, 36
  Grade Two, 36
  magnesium, **316**
  making of, 37–38
  materials for, 33
  quality of, 36–37
  size and weight of, 35
  styles in, 33–35
Beers, George, 177
Billet, definition of, 10
Blocking pads, football, 123
Body protector for catcher, 38
Boots, ski, 230–232
  care and repair of, 235
Bow, 9–20
  backed, 11
  care and repair of, 26–27
  combination wood and metal, 14
  composite, 11
  faced, 11
  laminated, 13
  metal, 14
  Oriental, 11
  parts of, 9
  properties of, 14–15
  qualities of, 9–11
  self, 11
  size of, 16–17
  styles of, 13
    duoflex, 13
    recurved, 13
    reflexed, 13
    straight, 13
  types of, 13–14
  weight of, 16–17
  wood for, 13–14
Bow case, 23
Bow rack, 23
Bow sight, 23
Bowling, 68–75
  ball for, 69–71
Bowling (*Continued*)
    care and repair of, 74
    mottled, 69
    solid black, 69
Bowling pins, 72, 73
  care and repair of, 74
Bowstring, 19
  care and repair of, 27
  serving of, 20
Boxing, 76–85
  early forms of, 76–77
Broughton, Jack, 77
Bulla, Johnny, 148

Calfskin, 302
Cap, baseball, 49–50
  size chart for, 50
Cartwright, Alexander, 28
Catcher's mask (*see* Mask, baseball)
Cellulose acetate butyrate plastics, 311
Cellulose acetate plastics, 311
Cellulose nitrate plastics, 311
Central Squash Committee, 215
Chest pads for lacrosse, 184
Cleats, 267
  for football shoes, 134–135
Clockgut, 179
Clothing as equipment, 272–298
  general sportswear, 278–288
  guides to selection of, 272–277
    care of textile fabrics, 275–277
    color, 273
    cost, 274–275
    function, 272–273
    garment construction, 274
    styling for action, 274
      (*See also* Costume; Uniform)
Cordovan leather, 15, 21, 22
Costume, for archery, 23–24
  for badminton, 204
  for bowling, 72, 74
  for fencing, 96–99
  for field hockey, 108–110
    blazer, 110
    hose, 110
    shoes, 110, 111
    tunic, 109–110
    warm-up suit, 110
  for golf, 157–162
  gymnasium (*see* Gymnasium costume)
  for lacrosse, 184
  for skiing, 226–232

Costume (*Continued*)
for squash, 204
for tennis, 204–206
(*See also* Uniform)
Cotton, 317–319
use of, in sports clothing and equipment, 318
Cowhide, 301–302
Crests on target arrows, 8
Crosse, 178–182
care and repair of, 185–186
specifications for, 180–182
Crosstex, 179

Discus, 252–253
care and repair of, 260
Doubleday, Abner, 28
Dresses, style of, 283
styling of, for action and fit, 338–339
Duck pins, 69, 72, 73
balls for, 71
Duelling sword, 93–94

Ebonite, 69
Elk leather, 303
Elliott, Frances, 107, 108
English Lawn Tennis Association, 187
Equipment, care and repair of, 261–271
supplies for, 262–263
(*See also* particular equipment)
clothing as (*see* Clothing as equipment)
materials for (*see* specific material)
test methods and procedures for, 326–333
Ethyl cellulose plastics, 311

Face guards, lacrosse, 183
Fastenings in sportswear, 343–344
Fencing, 89–100
early history of, 89–90
Fencing weapons, 90–96
blade in, 90–92
care and repair of, 99–100
dimensions for, 94
duelling sword, 93–94
foil, 93
guard in, 92
handles in, 92–93
mask, 95–96
pommels in, 93
sabre, 94
Feron, S. J., 215
Fibers, reactions of, generalizations on, 316–317
Field hockey, 101–113
balls in, 104–106
care and repair of, 112–113
game, 104–106
practice, 104–106
foot pads for, 107–108
goal guards for, 106–108
care and repair of, 113
shin guards for, 106, 107
care and repair of, 113
sticks for, 102–104
care and repair of, 111–112
length-weight measurements for, 104
restrictions in manufacture of, 102–104
specifications for, 104
Fletching, definition of, 7
Foil, 93
Football, 114–140
early days of, 114–115
Football equipment, 115–137
ball, 124–128
coated-fabric, 127–128
leather, 124–125
rubber-covered, 125–127
Fortisan, 11, 19

Gloves, baseball, 39–41
care and repair of, 58–59
catchers', 39
fielders', 40–41
first basemen's, 40
boxing, 77–79
care and repair of, 84
size chart for, 79
fencing, 98–99
golf, 161
handball, 247
for ice hockey, 172–174
lacrosse, 183
shooting, 22
skiing, 230
striking bag, 82
Goal net, lacrosse, 182
Goaltenders, padding for, 172
Golf, 141–166
group instruction in, accessories for, 155–157

Golf bags, 155
  care and repair of, 165–166
Golf balls, 142–148, 157
  balance of, 331
  care and repair of, 166
  construction of, 144–146
  cost of, 147–148
  cutting resistance of, 331
Golf clubs, 148–154, 157
  aluminum, 315–316
  irons, 150–152
    care and repair of, 164–165
  selection of, for length, 152–153
  woods, 148–150, 152, 153
    care and repair of, 162–165
Goodyear, Charles, 312
Goodyear Welt shoe construction, 51, 52, 135–136, 170, 258
Gut, 201–202
Gymnasium costume, 288–298
  hose, 295–296
  jackets, 295
  shoes, 296
  suits, 290–294
    for boys and men, 292–294
    for girls and women, 290–292
    tank, 296–298
    warm-up, 294
  supporters, 294

Hammer, 255
Hancock, George W., 53
Handball, 246–247
  glove for, 247
  specifications for, 246
Head covers, golf, 154–155
Head protector for boxers, 82–83
  care and repair of, 85
Headgear, football, 116–119
    care and repair of, 137–138
  skiing, 230
Helmets, for ice hockey, 174
  lacrosse, 182–183
  wrestling, 87
Hip pads, football, 122–123
  care and repair of, 138–139
Hockey (*see* Field hockey; Ice hockey)
Horsehide, 302
Hose, baseball, 50–51
  football, 134
  gymnasium, 295–296
  for ice hockey, 175
Hose (*Continued*)
  skiing, 228, 230
  soccer, 240
Hughes, W. L., 35
Humidifier for shuttlecock, 214
Hunsaker, H. B., 153
Hurdling, 248

Ice hockey, 167–176
  helmets for, 174
  shin guards for, 171
  skate sets for, 169–170
    care and repair of, 175–176
  stick for, 168–169
    care and repair of, 176
Injury pads, football, 123

Jackets, for fencing, 96–98
  gymnasium, 295
  for ice hockey, 175
  size of, 288
  skiing, 227-228
  style of 286–287
  styling of, for action and fit, 339
Javelin, 253–254
  care and repair of, 260
Jersey, football, 128–131
    care and repair of, 139–140
    size chart for, 131
  for ice hockey, 174
      (*See also* Shirt)

Kangaroo leather, 302–303
Kapok, 119–121
Keepers, definition of, 18
Kinzett brothers, 143
Knee pads, football, 123

Lacrosse, 177–186
  ball for, 182
    care and repair of, 186
  stick for (*see* Crosse)
Leather shoes, cleaning of, 264
  cleats on, 267
  drying of, 264–265
  oiling and greasing of, 265
  waterproofing of, 265–266
Leathers, 299–304
  for baseballs, 29
  care of, 303–304
  cordovan, 15, 21, 22
  tanning of, 300–301

Leathers (*Continued*)
alum, 301
chrome, 301
vegetable, 301
types and properties of, 301–303
calfskin, 302
cowhide, 301–302
elk, 303
horsehide, 302
kangaroo, 302–303
sheepskin, 302
Leg guards, baseball, 42–43
construction of, 43
design and dimensions of, 43
fiber of, 42
padding and straps for, 42
thread and stitching of, 43
Lie, definition of, 168
Littleway Stitch shoe construction, 51, 52, 135–137, 256
Loops, 20

McKay stitched shoes, 170
Markers, tennis, 203
Mask, baseball, 43–45
bar (alloy), 45
wire face, 44–45
fencing, 95–96
care and repair of, 100
Mat covers for wrestling, 86–87
Mats, canvas, care and repair of, 270
plastic, care and repair of, 271
rubber, care and repair of, 270–271
for westling, 86
care and repair of, 88
Menke, F. G., 215
Metals, light, care of, 316
types and properties of, 315–316
Miller, Myrtle K., 16, 24
Mineralite, 69
Mock, Harry, 117, 118
Mouthpiece for boxers, 83
Muffler, 77

Naismith, James, 60
National American Playground Association of the United States, 53
National Archery Association, 2
National Collegiate Athletic Association, 252, 254
Official Rules Committee of, 77
National Collegiate Football Rules, 124
National Duck Pin Bowling Congress, 69
National Federation of High Schools, 252, 254, 255
National Federation of State High School Athletic Associations, 61, 62
National Recreation Association, 53
Nelson, Byron, 153
Net, badminton, 211–212
care and repair of, 214
tennis, 192–194
aluminum, 315
care and repair of, 206–207
volley ball, 244–245
Nock, 14–15, 20
definition of, 7
Nylon, 202–203, 297, 320
use of, in sports clothing and equipment, 321

Pads, hip (*see* Hip pads)
for ice hockey, 170–174
shoulder (*see* Shoulder pads)
sliding, 45–46
Pants, baseball, 48–49
size chart for, 49
basketball, 65
boxing, 84
fencing, 98
football, 131–134
care and repair of, 140
size chart for, 133
golf, 160
for ice hockey, 174–175
skiing, 228
soccer, 240
style of, 285–286
shorts, 286
slacks, 286
styling of, for action and fit, 339–340
wrestling, 87–88
Parka, 228
Piles, 6
Pins, bowling (*see* Bowling pins)
Plastics, 310–312
care of, 312
thermo-, 311–312
thermosetting, 312
Points of aim, 23
Pole vaulting, 248
Protection cup for boxers, 82
Puck, 174

Quiver, 23

Racket games (*see* Badminton; Squash racquets; Squash tennis; Tennis)
Rayon, 321–323
  use of, in sports clothing, 322
Roosevelt, Theodore, 114
Rubber, 312–315
  care of, 315
  cold, 312, 314
  foam, 312–314
  properties of, 313
  vulcanized, 312, 313
Rubber thread, covered, use of, in sports clothing and equipment, 319

Sabre, 94
Saint-Didier, Henri, 90
Schmeisser, William C., 177
Schwinger, 85
Searles, W. R., 148
Seconds, tennis balls as, 190, 192
Shaughnessy, Clark, 116, 117
Sheepskin, 302
Shin guards, field hockey, 106, 107
    care and repair of, 113
  ice hockey, 171
  soccer, 239
Shirt, 283
  baseball, 46–48
    size chart for, 48
  basketball, 65–66
  boxing, 84
  size of, 284
  for skiing, 227
  soccer, 240
  style of, 284
  styling of, for action and fit, 339
Shoes, baseball, 51–52
  basketball, 67
  bowling, 74
    care and repair of, 75
  boxing, 84
  canvas, care and repair of, 267
  fencing, 99
  field, 258–259
  for field hockey, 110, 111
  football, 134–137
    cleats for, 134–135
    construction of, 135
    materials for, 134
  golf, 162
Shoes (*Continued*)
  gymnasium, 296
  jumping, 257–258
  leather (*see* Leather shoes)
  running, 258
  soccer, 240
    specifications for, 241
  track, 256–257
    care and repair of, 259
Shooting glove, 22
Short, W. M., 143
Shorts (*see* Pants)
Shot, 252
  care and repair of, 260
Shoulder pads, football, 119–122
    care and repair of, 1[illegible]–139
  in sportswear, 344
Shuttlecock, 212
  care and repair of, 214–215
  humidifier for, 214
  specifications for, 212–213
Skiing, 219–235
  binding for, 225
  costume for, 226–232
  poles for, 225
    care and repair of, 234–235
Skirts, style of, 283
  styling of, for action and fit, 339
Skis, 220–226
  aluminum, 222
  selection of, 222–224
  wax for, 226
  wooden, 220–222
    care and repair of, 232–234
    laminated, 221
Slacks (*see* Pants)
Sliding pads, 45–46
Soccer, 236–241
Soccer balls, leather-covered, 237–238
  plastic-coated, 239
  rubber-covered, 238–239
Softball, 52–59
  ball in, 54–56
    flattening of, 331–332
    leather-covered, 54–55
      finished, 55
      seams of, 55
    rubber and plastic-covered, 55–56
  bases in, 54
  bat in, 53–54
  body protector in, 54
  equipment for, 53–56

Softball (*Continued*)
mask in, 54
Spine, definition of, 3
Sportswear, functional, selection of, list for, 334–337
general, 278–288
good construction of, 341–344
details, 343
facing, 344
fastenings, 343–344
linings, 344
shoulder pads, 344
stitching, 344
Squash rackets, 216–217
care and repair of, 218
Squash racqu s, 215–218
balls for, 217–218
dimensions of, 218
Squash tennis, 215
rackets for, 217
Stave, definition of, 10
Striking bag, 80–81
care and repair of, 85
gloves for, 82
hanger for, 81
leather for, 81
lining and sewing of, 81
Supporters, 87, 294
size chart for, 294
Sweaters, 278–281
cardigan, 280–281
construction of, 281
pullover, 280
for skiing, 227

Tabs, finger, 22
care and repair of, 27
Tank suits, considerations in selection of, 296–298
fiber, fabric, and color, 297
style and size, 298
Target, care and repair of, 27
indoor range, 21
outdoor range, 20–21
specifications for, 20
Target covering, 23
Tee mats, 156
cocoa, 156
Tees, automatic, 156–157
peg, 156
rubber, 156
wooden, 157
Tennis, 187–208
Tennis ball, care and repair of, 206
manufacture of, steps in, 191
official approval of, 188–189
properties of, 189
wool felt for covering, 190
Tennis markers, 203
Tennis racket, 194–203
aluminum, 315
care and repair of, 207–208
component parts of, 195, 200
construction of, steps in, 194
cover for, 203
frame of, 196–200
grip of, 198–199
throat of, 197
impact resistance of, 332–333
measurements for, 199
presses for, 203
stringing of, 200–203
gut, 201–202
nylon, 202–203
Tennis and Racquet Association, 215
Tennis robot, 204
Textiles, 316–325
cotton, 317–319
covered rubber thread, 319
fibers, 316–317
nylon, 320–321
rayon, 321–323
wool, 323–325
Thermoplastics, 311–312
Thermosetting plastics, 312
Tillering, definition of, 11
Track and field, 248–260
uniform for, 255–259
Training bag, 79–80
Turned Shoe shoe construction, 135–136, 258

Uniform, basketball, 65–67
boxing, 83–84
football, 128–137
care and repair of, 139–140
soccer, 239–241
softball, 56
track and field, 255–259
wrestling, 87–88
(*see also* Costume)
United Bowmen of Philadelphia, 1
United States Golf Association, 154

United States Lawn Tennis Association, 187–189
United States Squash Racquets Association, 216, 217
United States Volley Ball Association, 242

Vaulting pole, 249–252
  bamboo, 249–251
  care and repair of, 259
  fiberglass, 252
  metal, 251–252
  selection of, 250
  testing of, 250–251
Vinyl plastics, 311–312
Volley ball, 242–245
  coated-fabric, 244
  leather-covered, molded, 243–244
    stitched, 242–243
  net for, 244–245
  rubber-covered, 243–244

Waring, Ralph G., 164
Warm-up suit and jacket, football, 134
Weapons, fencing (*see* Fencing weapons)
Weights, 254–255
  care and repair of, 260
Woods, 304–310
  for arrows, 3–4
  for baseball bats, 34–35, 37
  for bows, 13–14
  care of, 309–310
  comparative strength properties of 307
  defects in, 305–306
    brashness, 305
    checks, 306
Woods (*Continued*)
    flecks, 306
    knots, 305
    shakes, 306
    warping, 306
  identification of, 304–305
  types and properties of, 306–309
    ash, 306
    basswood, 306–307
    beech, 307
    birch, 4, 307–308
    cedar, 308
    chestnut, 308
    elm, 308
    hackberry, 308
    hickory, 14, 308
    lemonwood, 13
    maple, 308
    oak, 309
    osage orange, 14, 309
    persimmon, 309
    Port Orford cedar, 3, 4
    willow, 309
    yellow poplar, 309
    yew, 14, 309
Wool, 323–325
  use of, in sports clothing and equipment, 324
Wrestling, 85–88
  early forms of, 85
  mat covers for, 86–87
  mats for, 86
    care and repair of, 88
  protective supporters for, 87

Yarn windings for baseballs, 30–31
Yocom, R. B., 153